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Structural change and polarisation in the rural-urban divide

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Abstract

This paper analyses whether in the EU there is a growing economic divide between urban and rural regions. Typically in the EU-27 and elsewhere, urban regions thrive economically and are centres of business, education, innovation and technology. Rural regions in turn are economically and socially less prosperous and threatened by outward migration, brain drain and negative rates of population growth. The aim of the paper is to explore the latest trends in economic convergence in EU-27 NUTS-3 regions and to analyse whether, over the past 20 years, the polarisation between urban and rural regions has increased or declined. Second, the paper investigates the contribution of globalisation-related structural change to territorial economic development in the EU, and looks at whether or not an increasing specialisation in the production of tradable goods has benefited regional ecoomic growth. Finally, it analyses whether this structural change has had a different impact on urban and rural regions, and thus whether it has been a source of regional polarisation. Our results suggest that there was no increase in the polarisation of GDP per capita levels. Globalisation-related structural change had positive growth effects may have contributed to a reduction in regional GDP per capita disparities. This effect is not restricted to particular types of NUTS-3 regions, but applies equally to urban, intermediate and rural regions.

JEL codes: O18, O47, R11, R12

Keywords

Regional growth, convergence, polarisation, structural change

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1. Introduction

In practice, urban regions are thriving economically and are centres of business, education, innovation and technology. By contrast, many rural regions are economically weaker, with median GDP per capita 30% lower than the figure in urban regions.[1] Also rural regions are more frequently threatened by outward migration, brain drain and negative rates of population growth because they lack economic and social prospects. Thus, urban and rural regions tend to be at different starting points when it comes to either expanding existing or developing new sectors of economic activity, in particular in the context of globalisation. Still, from a theoretical perspective, the prospects for both urban and rural regions are not necessarily clear-cut. Agglomeration theory or endogenous growth theory, for example, would suggest that urban regions should reap the benefits of a shift toward the production of tradables, thanks to their economic and innovation potential. However, classical growth theory and the law of diminishing returns would incline us to the view that rural regions should benefit from investment in their tradable sectors.

These different potentials to benefit from globalisation-related structural change are also of importance for policymaking, especially with regard to EU cohesion policy. Its aim is to reduce the disparities between regions. For this policy, it is essential to know how structural change affects the distribution of GDP across regions. Because, if agglomeration forces do indeed prevail - thus giving urban regions the edge in developing and expanding their tradable sectors - that would lead to an increase in regional disparity. For EU cohesion policy, this would mean that in order to reduce regional disparity, it would actually have to go against market forces; but then it could be criticised for supporting an inefficient allocation of productive resources. By contrast, if convergence forces prevail, that would facilitate EU cohesion policy, since in this case it would support a natural trend toward convergence, and thus speed up the growth and convergence process for rural regions.

For these reasons, the primary aim of this paper is to explore the latest trends in economic convergence in EU NUTS-3 regions and to analyse whether, over the past 20 years, the polarisation between urban and rural regions has increased or decreased. Second, the paper investigates the contribution made by globalisation-related structural change to territorial economic development in the EU. In the paper, globalisation-related structural change is understood as a

[1] In practice, the actual differences in living standards between urban and rural regions might be smaller than suggested by the differences in the level of GDP per capita, due to headquarters and commuting effects.

shift towards the production of tradable goods, expressed as an increase in employment or value-added shares of, in particular high-technology intensive, manufacturing industries and knowledge intensive services. Thus, our analysis focusses on whether or not such shift has been beneficial for regional economic growth. In so doing, the paper analyses not only the changes in specialisation themselves, but also the effects of the underlying factors that determine both the potential that the regions have to benefit from structural changes such as innovation, education, physical, digital infrastructure or the quality of the region's institutions. In addition, this paper analyses whether the structural change has had a different impact on urban and rural regions, and thus whether it has been a source of regional polarisation. Finally, after summarising the results, it explores the policy options at the European, national and local levels that could support regions.

The underlying research question to these points is: 'Does globalisation-related structural change increase the economic polarisation between urban and rural NUTS-3 regions in the EU?'

Past developments suggest that European integration reduced spatial disparities between EU member states, but in many cases did not change the backwardness of rural areas, compared to urban ones (Ezcurra *et al.*, 2005). Technological and structural change, trade liberalisation and globalisation further alter the patterns of regional development, calling for new insights into how these phenomena could potentially affect the spatial distribution of economic and social prospects.

This study analyses the EU's urban-rural divide by eliminating three shortcomings in the existing research. First, to the best of our knowledge, earlier (even recent) analyses have taken a very narrow focus by considering only a few (out of a broad spectrum) selected factors in their models. Omitting some of the important determinants of spatial disparity leads to a fragmented understanding of the sources of rural development, especially if many of the factors overlap in their influence mechanisms and outcomes. Second, most empirical works have focused on case studies or econometric analyses that cover only a few countries, mainly old members of the EU. This may prevent a precise evaluation of the extent to which the existing findings can be generalised to any member of the EU. In other words, it is necessary to clarify which of the factors discussed are universal in terms of reducing the urban-rural disparities in all member states, and which have only a country-specific effect. Third, to the best of our knowledge, the effects of globalisation and structural change on economic growth and the disparity between urban and rural regions have seldom been analysed in recent years. Thus, our study provides an important update in that respect.

Therefore, our main objective is to define the key determinants that predict the economic polarisation of urban and rural regions in the EU. In doing so, we pursue the objective of examining how recent globalisation-related structural change has affected the extent and the features of the urban-rural divide in Europe.

The remainder of this paper is organised as follows. Section 2 reviews the existing literature on theoretical approaches and the available empirical studies on globalisation, structural change and economic development. Section 3 describes the data and methods used; Section 4 analyses recent trends in regional economic development; Section 5 looks at the role of structural change and globalisation in regional growth, using descriptive statistics; Section 6 provides an analysis of the relationship of three economic framework variables - physical infrastructure, quality of governance and innovation potential - to regional growth; while Section 7 provides an econometric analysis. Section 8 offers a summary and conclusion.

2. Review of the theoretical approaches and empirical studies

Both growth and trade theories shed light on the emergence of spatial inequalities through differences in the production structures. Neo-classical approaches link economic development to access to production factors, while considering productivity and technological change to be exogenous to the economy. Areas with more resource endowments are regarded as having a comparative advantage that allows them to grow faster (Dumais *et al.*, 2002). However, perfect competition is assumed to create the necessary conditions for an equilibrium growth path (Barro *et al.*, 1991). The free mobility of capital and labour ensures that economic activities are evenly distributed across regions. Thus, investment from outside and the free movement of workers should eliminate spatial disparities in economic wealth (Cheshire & Malecki, 2003).

Endogenous growth theories reject the exogeneity assumption by interpreting technological change as a result of economic activities (Romer, 1990; 1994). While looking for possible sources of shifts in technology, major studies focus on human capital and investments in research and development (R&D): educating the labour force and investing in research should result in innovations, leading to increases in productivity. In addition to the direct contribution of these factors, growth theory proposes that their spill-over effects in themselves become important determinants of regional development. According to this view, regional disparities are recognised as possible, emerging largely as a result of differences in technology and productivity that are caused by cross-regional variation in the quality of human capital, the investment in R&D, the rate of innovation and the size of the spill-over effects.

Trade liberalisation removes barriers to the free exchange of goods between nations, significantly altering the trajectory and determinants of regional development. First, openness to trade increases the size of markets, bringing trade costs into the equation (Ottaviano & Thisse, 2003). Accessibility to markets becomes central in explaining the spatial allocation of production, by linking the tendency to locate in certain regions to the level of transportation costs and those regions' infrastructural endowments (Krugman & Venables, 1990). Global players are expected to emerge primarily in areas that enjoy good accessibility to and that are accessible by large markets (Overman *et al.*, 2001).

Secondly, trade liberalisation increases competition in many economic sectors (DG Regio, 2008). The emergence of global markets for products or production factors and of new sectors with very different cost structures creates new risks for regional development. It is primarily vulnerable sectors (such as textiles or mining) that are prone to restructuring crises, and these are usually located in rural areas (DG Regio, 2009). By contrast, urban regions with dynamic manufacturing sectors benefit from globalisation and become global players. The competition also increases inside firms (at the functional and task levels, on a task-by-task basis), requiring robust reallocation at the spatial level through off-shoring and outsourcing of production phases.

Thirdly, global competition creates pressure for the local adoption of industrial transformation, based on 'megatrends' such as digitalisation, the acceleration of innovation, or heightened sustainability concerns. Spatial disparities in economic development are now interpreted through the ability of regions to adopt new technologies or push through technological change (DG Regio, 2008). Achieving these objectives is still seen as possible using standard endogenous mechanisms, notably through investments in human capital and R&D. Again, it is significantly more challenging for a rural region to promote a technological shift than it is for an urban region - and this exacerbates the urban-rural divide within countries affected by globalisation (Mayer *et al.*, 2016).

Lastly, trade openness and globalisation promote the deindustrialisation of regions, while reinforcing the shift to a services-based economy (DG Regio, 2009). However, studies warn that regions should avoid a simple replacement of service jobs for jobs in industry. Instead, they should make sure that the increase in service jobs is accompanied by an increase in private sector productivity, and should compensate for the decline in industrial employment by boosting industrial productivity (DG Regio, 2008). Only in this way can regions attract foreign direct investment in their area of specialisation and thus profit from trade liberalisation and globali-

sation. Given the specificity of rural production structures, the transition to a services-based economy is again recognised as problematic in non-urban regions, contributing to a widening of the urban-rural gap.

Due to the many challenges, trade liberalisation and globalisation have undermined the validity of conventional approaches to regional development. The new economic geography has attempted to remedy the situation by introducing increasing returns to scale and the idea of agglomeration (Ottaviano & Thisse, 2003). Accordingly, the agglomeration of economic activities is expected to bring cumulative gains in terms of regional wealth. This is because agglomeration is positively associated with economic gains and correlates negatively with transportation costs, due to economies of scale (Krugman, 1991). It is, hence, able to increase firms' revenues through mutual interactions and interdependencies, resulting in improved efficiency and comparative advantages (Krugman, 1996). Exploiting economies of scale through agglomeration is recognised as especially important for global players (DG Regio, 2008). Because of this, regional disparities have been reinterpreted as being linked to the cross-regional variation in the degree of within- and cross-border agglomeration (McFarland & Grabowski, 2022).

In turn, the pace and degree of agglomeration have been understood as dependent on a region's characteristics. While trade enhances spatial agglomeration within those regions that enjoy the advantages of location and a large home market, it induces dispersion within those regions that lack access to global markets or that are historically disadvantaged (Guevara-Rosero, 2017). Owing to this, agglomeration is expected to occur primarily in urban areas. By contrast, spatial concentration is unlikely to take place in rural areas - especially not in those that are dominated by agriculture, characterised by constant returns to scale and employing largely immobile resources. Instead, rural regions can experience a concurrent rise in a diverse range of micro-businesses (Bosworth & Venhorst, 2018), whose production is likely to be directed or consumed disproportionately by people with strong ties to urban and big city populations (Lichter & Brown, 2011).

At the same time, studies emphasise the fact that globalisation not only threatens local economies, but also creates new opportunities. Globalisation can drive productivity increases either through technological transfer or competition (DG Regio, 2008). Competition enforces the natural selection of the most efficient local firms, functions and activities, with a consequent increase in productivity at an aggregate level for the home areas (DG Regio, 2009). Still, those home areas - and especially manufacturing regions - risk losing local core functions, local specific expertise and skills that define local competitiveness.

In summary, trade liberalisation and globalisation strongly affect regional development. However, regional disparities are still attributed to cross-regional variation in their endogenous endowments of strategic assets like human capital, innovation capability and high-level functions. Regions with a greater capacity to gain economic opportunities from global markets are characterised by a large share of highly educated people in the labour force and management. Similarly, regions that benefit from globalisation are those that have increased productivity growth rates thanks to policies that support innovation. Such policies include not merely the degree of R&D expenditure, but also efforts to increase knowledge so as to foster sectoral transformation and develop local capabilities to cooperate synergically with other regions.

The winning strategies usually involve increasing manufacturing productivity in the local sectors of specialisation, using new technologies, organisational and managerial innovation, and the reconversion of regions to higher phases of the production process by decentralising low-level production phases, using areas with lower wages and production costs (Marelli, 2007). Thus, the region can preserve its specialisation, even if this comes at the expense of job losses. Reconversion of the regional sectoral structure from low value-added to high value-added sectors also includes specialisation in high-level service activities, while avoiding a simple wholesale replacement of manufacturing with service jobs (DG Regio, 2008). During this structural shift, it is important for regions not to lose manufacturing entirely, but rather to keep the highest value-added phases and functions. This is because innovation tends to take place more rapidly in manufacturing than in services; hence, the presence of manufacturing guarantees a high rate of innovation in the region.

Regions that specialise in manufacturing should avoid losing those core competencies on which their comparative advantage rests (Midelfart-Knarvik *et al.*, 2000). Maintaining high-value manufacturing activities is easier when regions balance core manufacturing activities and other related activities that often belong to the service sector. Interestingly, many studies have demonstrated that growth in high-value services (business services) is closely linked to growth in manufacturing productivity, especially for firms functioning at the global level. However, the balance between services and industry is not sufficient if regions cannot maintain a certain level of innovation. As such, differences in the degree of success in promoting structural change are recognised as the basis for the different economic performances of regions in the case of both global and regional players.

Research conducted so far generally supports the major impact of technological change, trade liberalisation and globalisation on urban-rural disparities (DG Regio, 2009). The initial gap

between the two types of regions is, however, attributed to variability in the industry mix across the regions (Ezcurra *et al.*, 2005). Urban regions that specialise in dynamic, high-growth industries are able to perform better, while rural regions, which specialise mainly in less-competitive and less-productive sectors (such as textiles or mining), fall behind (DG Regio, 2008). Particularly vulnerable are those regions that specialise in agriculture (Marelli, 2007). Rural regions are also disproportionately affected by increased global competition (DG Regio, 2009). The ultimate impact depends, however, on the structural differences of regions, created by variation in the stock of human capital or in spending on research and development (Ezcurra *et al.*, 2005).

The issue of human capital has attracted particular attention in discussions about the urban-rural divide in Europe (Midelfart-Knarvik *et al.*, 2000). Studies have repeatedly demonstrated that people who live and work in cities benefit from globalisation and innovation, since urban areas offer better education and connections. By contrast, people in rural areas have fewer such opportunities, and that undermines their economic mobility (OECD, 2018). Technological change further intensifies the process of division: technology requires the constant upgrading and reacquisition of skills, and cities provide greater opportunity for this. Rural communities tend to experience slow technological progress and to have a concentration of relatively low-skilled labour (Bosworth, 2010). Jobs in rural regions face the highest risk of task automation, which may explain the decline in the popularity of such regions as places in which to live or work (OECD, 2018).

The comparative advantage of cities in terms of the quality of the labour force contributes to the agglomeration of research activities in urban regions, focusing on the needs and interests of their industries. At the same time, rural production needs new technologies to reduce trade costs and open up fresh market opportunities for them (OECD, 2019). New technologies can enable rural goods and services to reach more distant markets at lower cost and with greater speed than today. As Xu (2017) and Reuters (2017) demonstrate, such innovations as driverless trucks or drone-based deliveries can significantly reduce transportation costs and shipping times, helping rural regions to overcome the challenges of geography and infrastructure.

Greater use of new technology also attracts a better-educated labour force to rural communities, by holding out the prospect of better and more diversified jobs in such regions. According to Clark (2018), rural areas are often characterised by lower living costs, while greater internet connectivity can make remote working possible. Thus, it can improve the desirability of rural locations and reduce the costs associated with being outside an urban region (Hudson, 2011). As Lichter and Brown (2011) demonstrate, rural communities with high amenity values and

good connections to urban areas are well placed to benefit from the outflow of the population away from congested cities.

In practice, though, digitalisation has actually contributed to increasing the regional gap. As a 2019 OECD report suggests, digital connectivity is worse in rural communities than in towns, which leads to an urban-rural digital divide in many forms. Townsend *et al.* (2013) refer to regional disparities in devices and in the machine-to-machine connectivity that is crucial if the full functionality of new technologies (such as autonomous cars) is to be embraced. Price *et al.* (2021) report that such disparities also exist in access to broadband, which is increasingly necessary for the delivery of information, health, education, business, social security, public and leisure services.

Participation in a progressively digital economy is vital for rural regions, as they strive to overcome the problems of physical and social isolation; and yet they remain those areas most excluded from developments in fast broadband. This is not exclusively on account of technological or economic barriers to reaching the more remote locations: it is also due to the rural population's inadequate knowledge and skills. As a consequence, rural communities face problems in terms of both accessing broadband technology and the willingness or ability of residents to adopt such technology (Townsend *et al.*, 2013). As Kastrop *et al.* (2019) conclude, digitalisation and poor connectivity can only exacerbate the existing urban-rural economic disparities.

The slow rate of digitalisation, coupled with low population density and shrinking local markets, is erecting insurmountable obstacles in the way of the agglomeration process in rural regions (OECD, 2019). Firms in small, rural economies struggle to compete against firms in urban areas that can produce higher volumes at more strategic locations that are closer to customers. Globalisation mainly fosters the concentration of agglomeration economies in cities (McFarland, 2019). This trend can only increase spatial inequalities, leaving many rural places lagging even further behind (Thisse *et al.*, 2013).

In response to these challenges, European national governments have developed various types of regional policies (Bachtler *et al.*, 2014). While the form of their interventions may vary in terms of objectives, strategies and instruments, the common denominator for all of them is a primary focus on infrastructure and the labour market (Hacker, 2021). Measures include publicly financed housing construction, improved digital infrastructure, stronger public social and health-related services, and expanded public transport. In addition, many countries attempt to invest more in regional education, training and science programmes (Hacker, 2021).

Despite all the joint efforts, EU member states still vary significantly in terms of their success in reducing economic and social disparity between urban and rural communities.

3. Data and methodology

This paper analyses the effects of globalisation-related structural change on the economic polarisation between urban and rural regions in the EU.

The EU regions are defined at the highly geographically disaggregated EU NUTS-3 level. At this level, Eurostat defines three types of regions, according to their level of urbanisation:[2] urban regions, intermediate regions and rural regions. The classification of regions is determined in a three-step approach. First, urban clusters are defined as areas with least 300 inhabitants per km^2 and a minimum population of 5,000. Rural areas are outside these clusters. Second, each NUTS-3 region is classified as:

- rural, if more than 50% of its population lives in rural areas;
- intermediate, if the share of the population living in rural areas is between 20% and 50%;
- urban, if less than 20% of the population live in rural areas.

The third step includes some fine tuning, depending on whether a rural or intermediate region contains urban centres with over 200,000 and over 500,000 inhabitants, respectively. In such cases, rural regions are reclassified as intermediate and intermediate regions are reclassified as urban.

Economic polarisation is understood as an increase in NUTS-3 regional disparities in terms of GDP per capita at purchasing power standards (PPS). To measure polarisation, among other tools we use the mean logarithmic deviation (MLD). The measures have the advantage that they can be additively decomposed (see Shorrocks, 1980; Mookherjee & Shorrocks, 1982; Jenkins, 1995).

The MLD is defined as:

$$I = \frac{1}{n}\sum_{i} \log\left(\frac{\mu}{y_i}\right)$$

[2] https://ec.europa.eu/eurostat/web/rural-development/methodology

where n is the number of observations, μ is average GDP per head, and y_i is the GDP per head of a region i. The lower bound of this index is 0, i.e. no inequality.

This index can be decomposed by groups of regions, so that overall inequality is the sum of the inequality within each group of regions and the inequality between the groups of regions. More formally, this decomposition is written as:

$$I = \sum_k v_k I^k + \sum_k v_k \log(1/\lambda_k)$$

where v_k is the share of group k's population in the total population, I^k is the MLD of group k and λ_k is the relative mean GDP per capita of group k, i.e. the ratio of group k's mean GDP to the overall mean GDP. The first term on the right-hand side represents the within-group inequality and the second term the between-group inequality.

Globalisation-related structural change is proxied by the change in the gross value added (GVA) and employment shares of the tradable sector, in particular the medium- and high-technology-intensive manufacturing sector and the knowledge-intensive services sector – though most of the analysis focuses on the former. It is our understanding that regions expanding their tradable sector (i.e. increasing their share in total regional value added or employment) are highly competitive regions and are therefore likely to benefit through higher GDP growth rates.

For the analysis, we follow Eurostat[3] and define the high- and medium-high-technology-intensive manufacturing sector as consisting of the following sectors (NACE rev. codes in brackets): (a) Manufacture of basic pharmaceutical products (21); (b) Manufacture of computer, electronic and optical products (26); (c) Manufacture of chemicals and chemical products (20); and (d) Manufacture of electrical equipment, Manufacture of machinery and equipment, Manufacture of motor vehicles, Manufacture of other transport equipment (27-30). Knowledge-intensive services are also defined according to Eurostat.[4]

To apply this to EU regions, we use sectoral employment data from Eurostat's Structural Business Statistics. These data have two serious drawbacks. First, they need a significant amount of data preparation (e.g. harmonising with national data, filling gaps, adjusting for changes in the regional division of countries, etc.). And second, they are only available at the NUTS-2 level.

[3] https://ec.europa.eu/eurostat/cache/metadata/en/htec_esms.htm; Annex 3.
[4] Because of data limitations at the regional level knowledge-intensive services were defined at the NACE rev.2 1-digit level and were limited to market services and thus including public services. They include: Information and communication (J), Financial and insurance activities (K), Real estate activities (L) and Professional, scientific and technical activities (M).

Since we want to focus on the NUTS-3 level of regions, we employ a dual strategy in the econometric analysis. First, we estimate a spatial hierarchical model, which lets us exploit NUTS-2 level information for the NUTS-3 level analysis. Secondly, we additionally/alternatively use, as a proxy, the much more aggregated sectoral gross value-added data available in the ARDECO database and Eurostat. These data only have information for NUTS-3 regions on the industrial sector as a whole – i.e. manufacturing industries, mining and energy. Our results suggest that these data are a fairly good proxy for the more sectorally detailed NUTS-2 data.

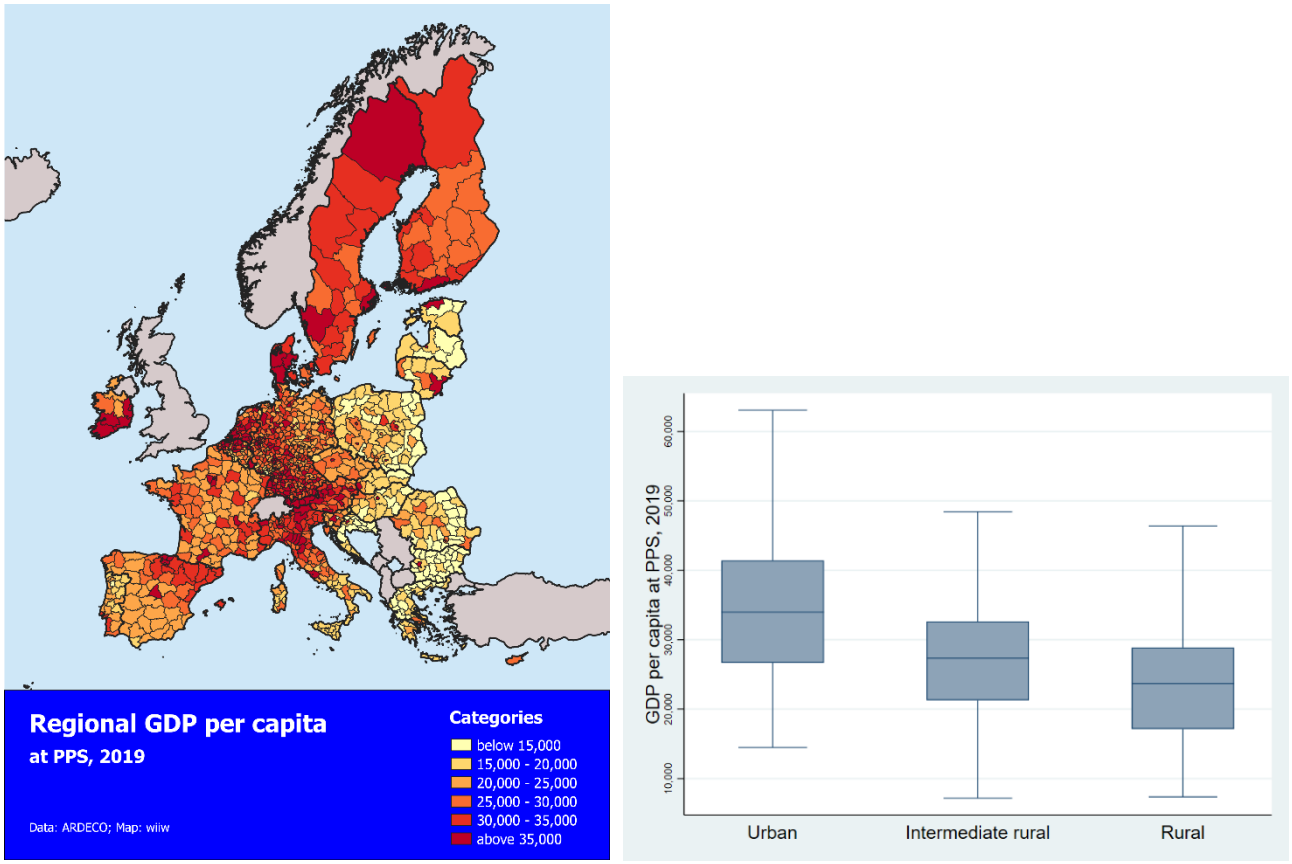
4. Recent trends in economic development

As of 2019, the EU is still characterised by major differences in the levels of regional economic development. From a geographical perspective (Figure 1, left-hand map), the EU can be said to be split into three parts. First, we can identify an 'EU-East', which includes all NUTS-3 regions in Bulgaria, Croatia, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia. Those countries have the least-developed NUTS-3 regions in the EU: many of them had GDP per capita levels (at PPS) of below 20,000 euro in 2019. Notably, disparities also exist within the EU-East countries, partly along geographical lines (with more-developed regions in the West and less-developed regions in the East) and partly along functional lines (with high-income capital city regions and low-income agricultural regions).

The second group covers the 'EU-South' regions. These are generally regions with medium GDP per capita levels (in comparison to the EU average) and include regions in Cyprus, Malta, Portugal and Spain, as well as Southern Italy. For geographical/historical reasons, we also include the Greek regions in the group of EU-South regions, despite their low GDP per capita levels. The third group consists of high GDP per capita regions. They are located in Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy (its Northern regions), Luxembourg, the Netherlands and Sweden. For this analysis, we term them 'EU-North'.

Alongside the geographical disparities, EU regions are also characterised by economic disparities between regions with different degrees of urbanisation. Figure 1 (right-hand graph) shows that urban NUTS-3 regions - on average - tend to have higher GDP per capita levels than other regions. Their median GDP per capita was around 34,000 euro in 2019. The median income of intermediate regions was around 27,000 euro, while the corresponding median of rural regions was 24,000 euro – around 30% lower than the median GDP per capita of urban regions.

Figure 1. Regional GDP per capita in PPS, 2019, left: geographical perspective; right: by degree of urbanisation



A look at the development of GDP over time (i.e. from 2000 to 2019) reveals a strong growth performance in the EU-East: there, the GDP per capita of most NUTS-3 regions grew at well above the EU average growth rate (see Figure 2, left-hand map). By contrast, regions in the EU-South - and particularly in Greece and Southern Italy - grew at below the average; meanwhile many regions - overwhelmingly in the EU-North - grew at around the average EU growth rate.

From a typology perspective, rural regions on average grew at a faster pace than other regions (median GDP per capita growth of 1.3% per year). The median growth rate of intermediate regions in 2000-2019 was around 1.1%; while the lowest median growth rate was recorded by urban regions (0.9%) (see Figure 2, right-hand graph).[5]

A consequence of the strong growth in EU-East regions and the above-average growth performance of rural regions there was a convergence of GDP per capita levels during the period 2000-2019. This is illustrated by Figure 3 (left-hand side), which shows a plot of GDP per capita growth rates in 2000-2019 against (the natural logarithm of) GDP per capita levels in 2000.

[5] A k-sample test on the equality of medians rejected the hypothesis of equal GDP per capita medians across the three types of regions.

Figure 3 (right-hand side) shows the corresponding GDP level and growth correlation for the post-crisis period 2009-2019. During this phase, GDP convergence of the NUTS-3 regions became considerably weaker, especially as growth in the lower GDP per capita regions of the EU-East often did not reach pre-crisis levels, with some regions even suffering economic decline.

Figure 2. Real regional GDP growth rates 2000-2019, in %, annual average growth rates

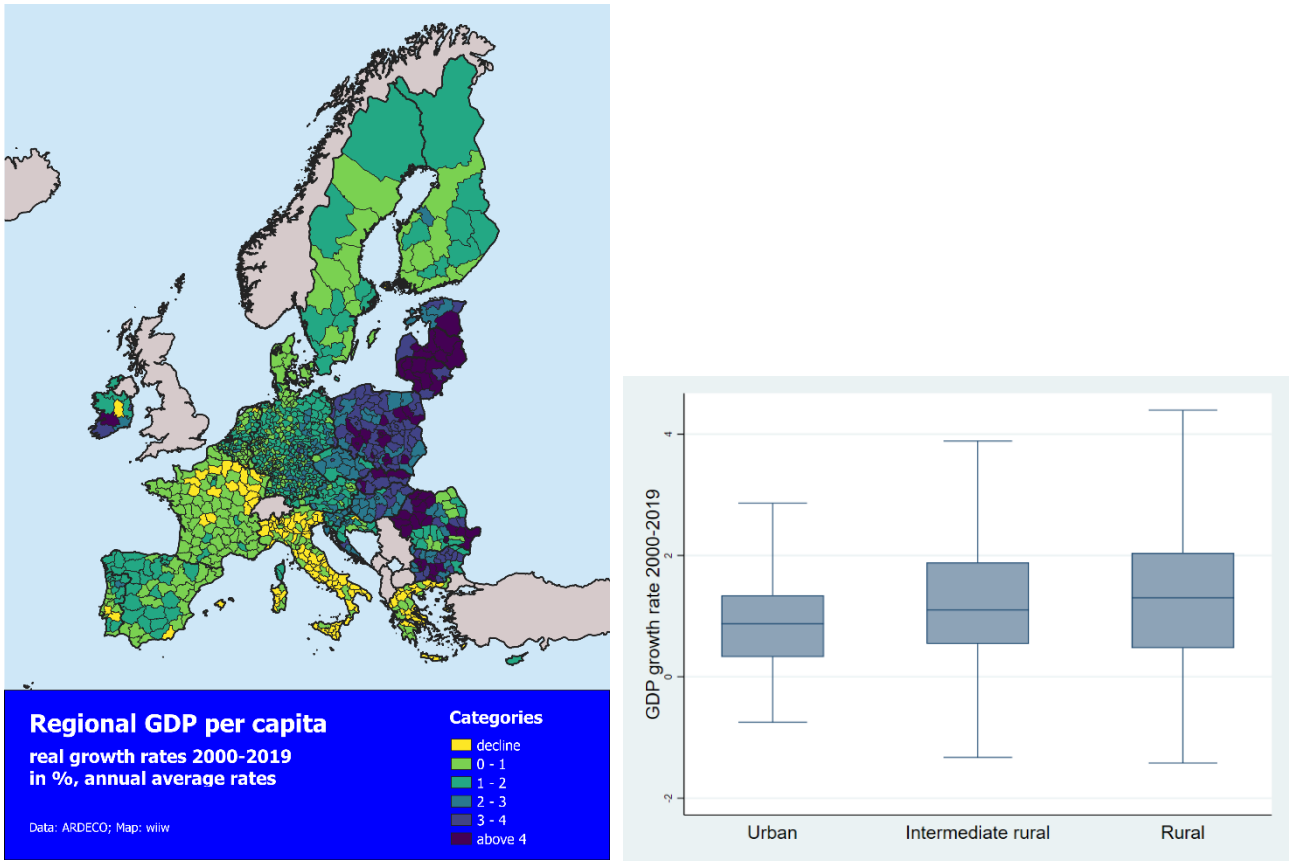
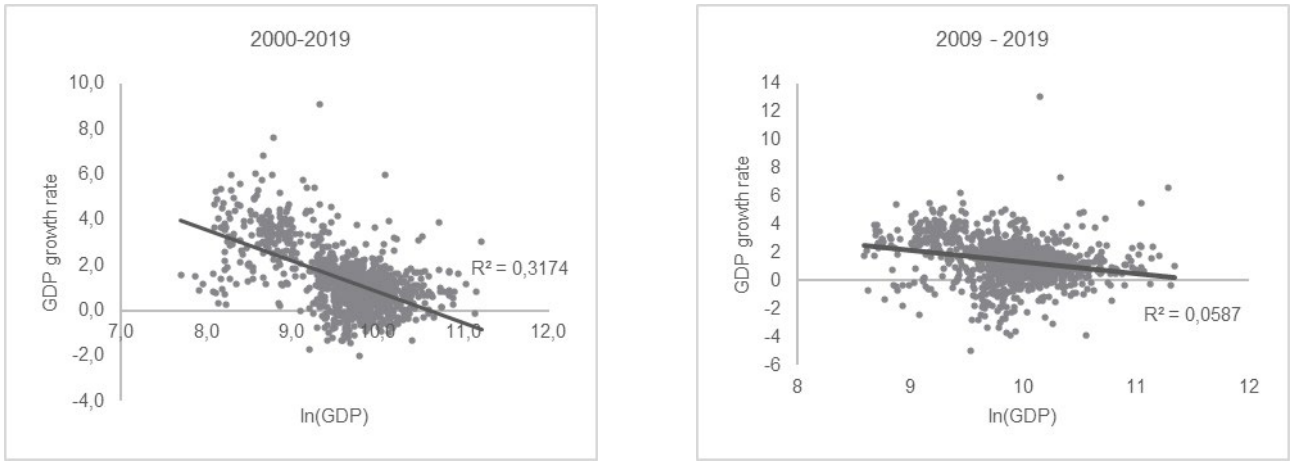


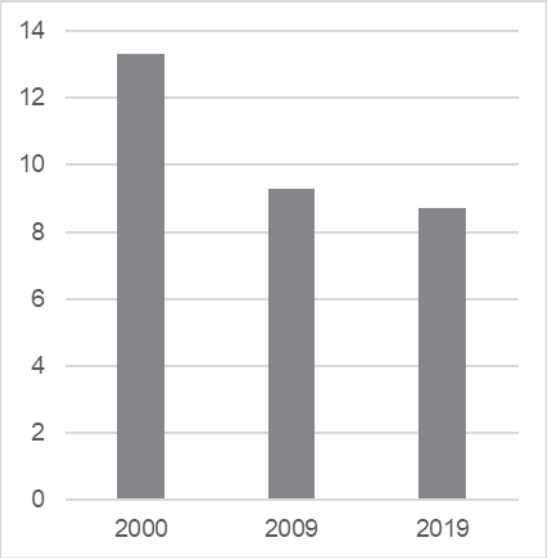
Figure 3. GDP convergence 2000-2019 and 2009-2019



Source: ARDECO, own calculations

These growth tendencies also had repercussions for the polarisation of EU NUTS-3 regions. This is illustrated by the MLD of the GDP per capita levels in NUTS-3 regions for the years 2000, 2009 and 2019 (Figure 4). This shows that, from 2000 to 2009, regional inequalities - and thus polarisation - fell; whereas from 2009 to 2019 they remained nearly constant.

Figure 4. Mean logarithmic deviation, NUTS-3 GDP per capita in PPS

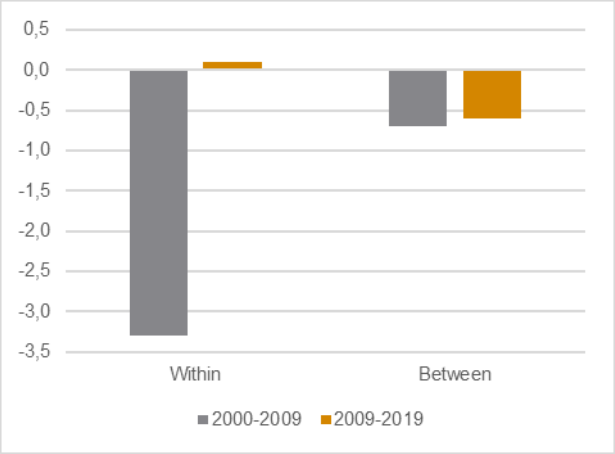


Source: ARDECO, own calculations

Taking advantage of the additive properties of the MLD, we split it according to the urban typology of regions to show the contribution of urban, intermediate and rural NUTS-3 regions to the development of regional GDP per capita inequalities in the EU.

Analysing first the contribution of between- and within-group inequality to total regional inequality (Figure 5), we see that the main reason for the strong decline in regional GDP per capita disparities from 2000 to 2019 was a reduction in within-group inequality; meanwhile, there was little convergence between the three regional groups. By contrast, from 2009 to 2019, the reduction in inequality was driven by reductions in both within- and between-group inequalities.

Figure 5. Contribution of within- and between-group variation to total MLD change



Note: Regional groups are: urban, intermediate and rural regions.
Source: ARDECO, own calculations

These findings are corroborated by Table 1, which disentangles the MLD by urban, intermediate and rural regions and shows (a) the respective group inequality and (b) mean GDP per capita levels relative to the EU GDP per capita level for the years 2000, 2009 and 2019.

The results confirm that between 2000 and 2009, within-group inequality decreased in each regional group, while mean GDP levels changed only marginally. Thus, during this period we can observe a group convergence process, where the urban, intermediate and rural regions converged towards their group-specific mean GDP per capita level, but there was no convergence between groups. From 2009 to 2019, these developments were different: while within-group convergence slowed considerably, inequality (and hence polarisation) was also slightly reduced by the convergence of the group-specific mean GDP levels. Thus, though convergence became weaker in the period 2009-2019, the pre-crisis trend of an exclusive group convergence process was overcome, leading to a (weak) convergence across the three types of regions.

Table 1. Regions by urbanisation: within-group inequality and relative mean incomes

	2000	2009	2019
Within-group inequality			
Urban	9.30	7.50	7.80
Intermediate	12.00	8.20	7.80
Rural	12.60	7.50	7.10
Relative mean GDP per capita			
Urban	1.34	1.33	1.28
Intermediate	0.99	0.98	0.99
Rural	0.82	0.83	0.85

Source: ARDECO, own calculations

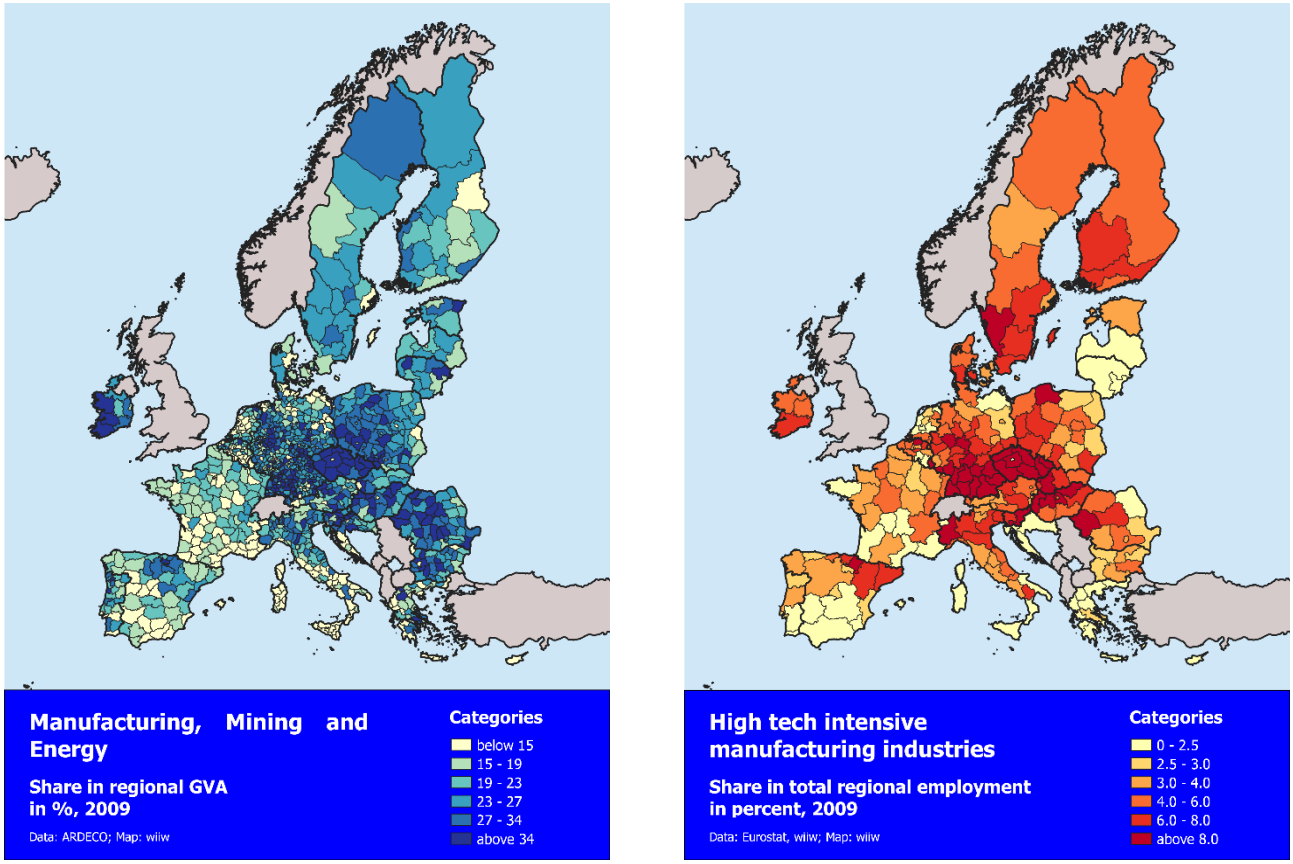
5. The role of structural change in economic growth

In this section, we provide a descriptive analysis of the importance of globalisation-related structural change for regional economic growth and the polarisation of EU NUTS-3 regions. We start with an analysis of the status quo of regional specialisation in the manufacturing sector. Because we are working at the NUTS-3 level of regions, it is hard to get hold of sectorally disaggregated data that adequately capture the manufacturing sectors most affected. Therefore, we add NUTS-2 level data to the analysis, in order to provide a greater level of sectoral detail. In the whole analysis, the effects of globalisation enter only indirectly, as detailed trade data are thin on the ground and their availability depends very much on the existing regional industrial structure. Thus, globalisation is proxied at the NUTS-2 level by the regions' employment share in high-tech-intensive manufacturing industries. At the NUTS-3 level, because of data limitations, it is proxied by the gross value added share of total manufacturing (see also the data section above).

Starting with the NUTS-3 level, the left-hand map in Figure 6 shows the share of industry in total regional GVA in 2009 (to account for the changes in growth trajectories after the economic and financial crisis in 2008/2009). It reveals an industrial divide in the EU, with countries and regions in the centre and the East of the EU having particularly high shares of industrial GVA. By contrast, countries and regions in the South and West have comparatively low shares of industry in total GVA.

The map on the right-hand side shows the employment share of high-tech-intensive manufacturing industries in total employment in the NUTS-2 regions in 2009. As with the more sectorally aggregated NUTS-3 level data, the regions in the centre and the East tend to have a higher employment share than most other regions in the EU.

Figure 6. Left: Manufacturing, mining and energy – share in regional GVA; Right: High-tech intensive manufacturing industries – share in regional employment, 2009, %

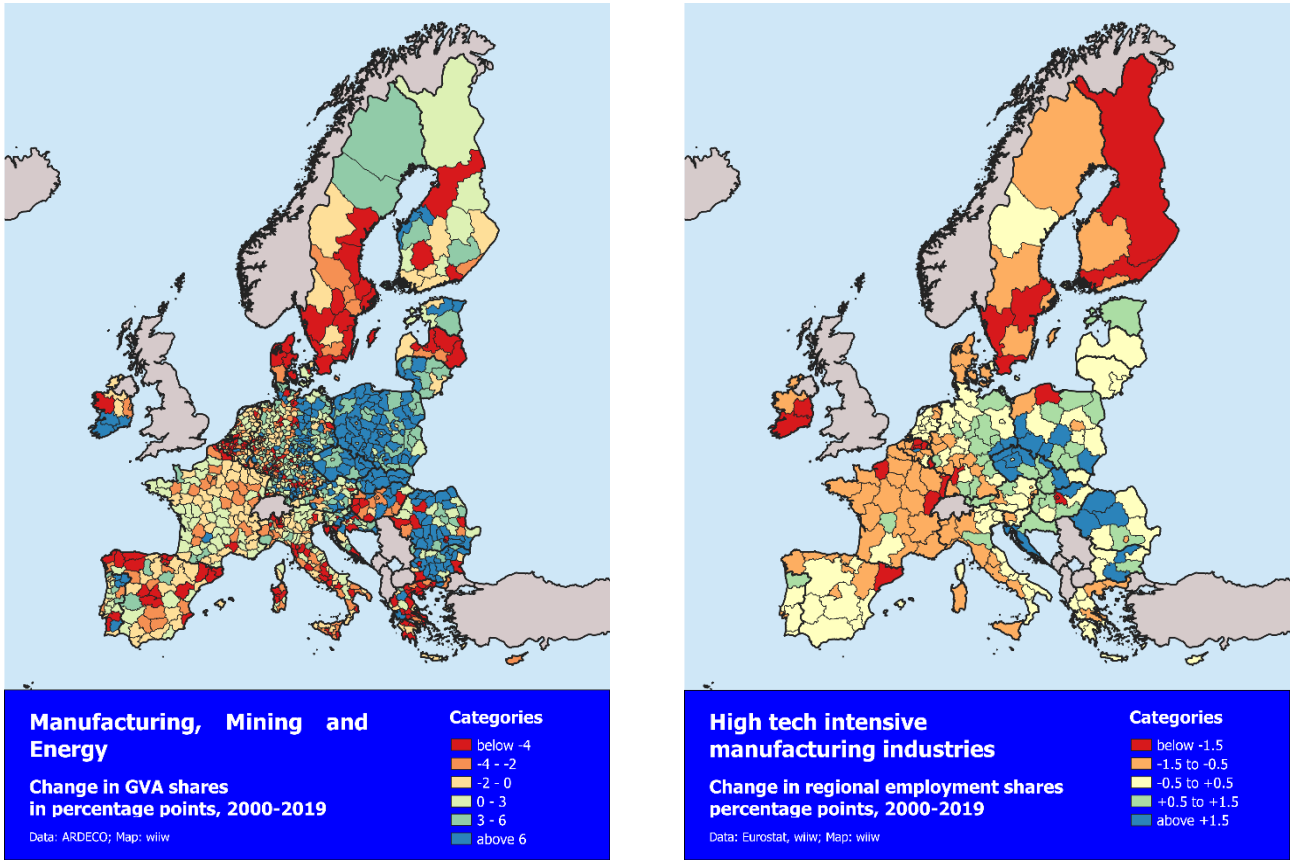


When analysing the extent of structural change, this is interpreted at the NUTS-3 level as the change in the GVA shares of industry, and at the NUTS-2 level as the change in the employment share of high-technology-intensive manufacturing industries during the period 2000-2019.

The results indicate pronounced differences in the extent of structural change in the EU. Hence, the EU-East NUTS-3 regions – as well as certain regions in the EU-North (e.g. Austria, Germany, Ireland) - show a big increase in the share of industrial GVA, whereas in most other regions industry expanded only slowly - or even declined, as, for example, in Greece, parts of Spain, Italy and Sweden.

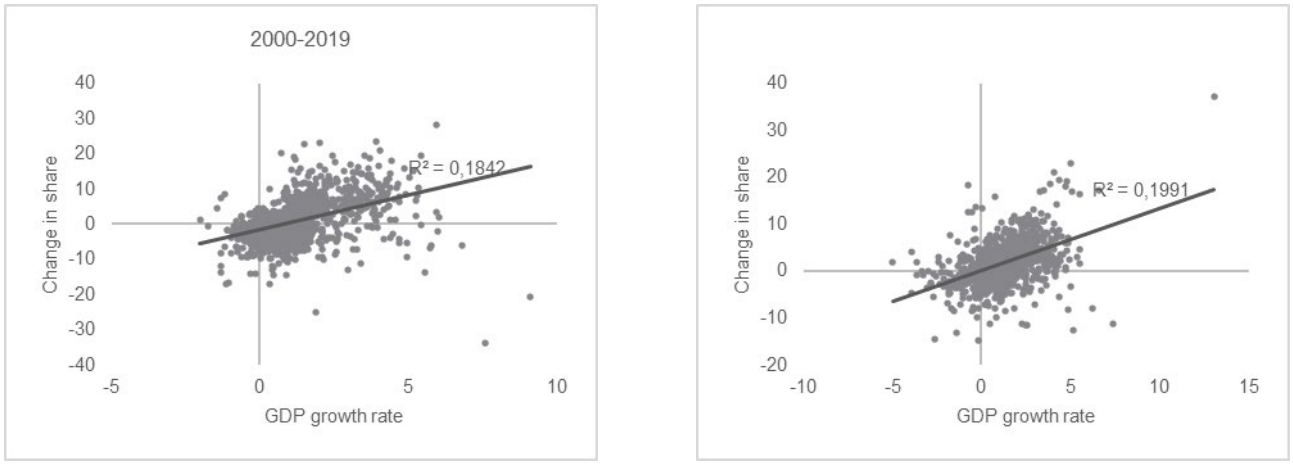
As for the NUTS-2 level and the changes in the employment shares of high-tech manufacturing industries, the situation is similar. In most regions of the EU-East, as well as regions of Austria and Germany, the employment shares of those industries increased from 2000 to 2019, while they declined in parts of Greece and Spain, Italy, Finland and Sweden.

Figure 7. Left: Change in GVA shares: Manufacturing, mining and energy; Right: Change in employment shares: High-tech intensive manufacturing industries, 2000-2019, percentage points



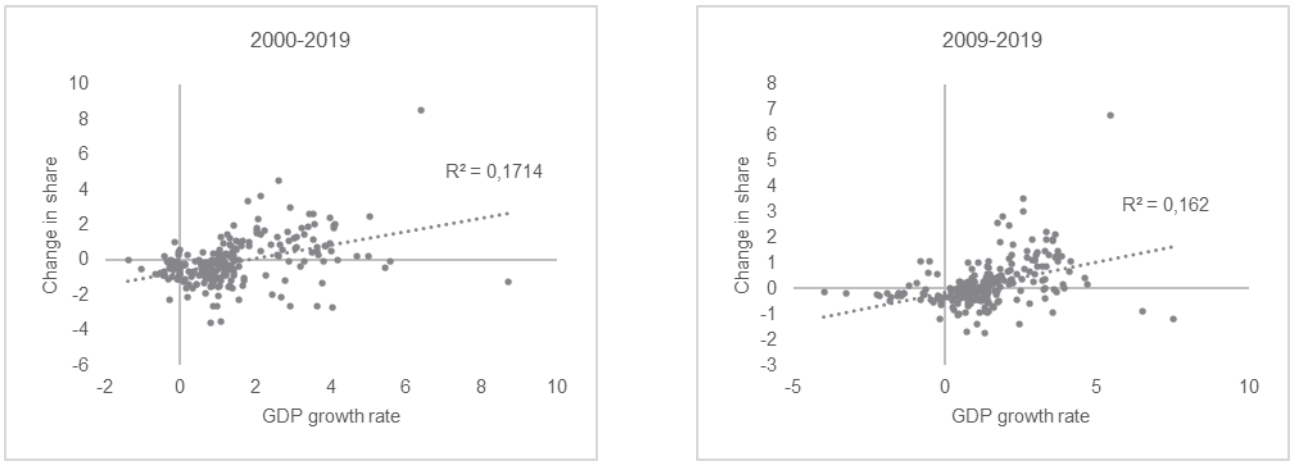
To get a first impression of whether structural change might be connected to economic growth, we correlate the change in industry GVA share in total GVA, as well as the change in high-tech manufacturing industries share in total employment and GDP per capita growth rates. This is shown in Figure 8 and Figure 9, respectively. The left-hand graph shows the correlation for the period 2000-2019 and the right-hand one the correlation for 2009-2019. We find a weak positive correlation between an increase in the industry share in GVA and GDP growth rates, as well as in the employment share of high-tech manufacturing industries and GDP growth rates.

Figure 8. Correlation: Change in NUTS-3 industry GVA share and GDP growth rates, both %; left-hand graph: 2000-2019, right-hand graph: 2009-2019



Source: ARDECO, own calculations

Figure 9. Correlation: Change in NUTS-2 high-tech-intensive manufacturing industry employment share and GDP growth rates, both %; left-hand graph: 2000-2019, right-hand graph: 2009-2019



Source: Eurostat Structural Business Statistics, own calculations

To analyse the effects of structural change on inequality and polarisation across regions, we expand the MLD from the previous section further, splitting in turn the urban, the intermediate and the rural regions into two groups: one group consists of regions where the industry share in total GVA increased; the other group consists of regions where the share either remained constant or declined. The results are shown in Table 2. They indicate that, irrespective of regional group, convergence was much stronger in those regions where the share of industry in GVA increased. That is a shift towards industry is associated with similar positive growth effects in urban, intermediate and rural regions. There was a strong tendency toward a within-group convergence of those urban, intermediate and rural regions with an increasing industry share. In practice, this was mainly driven by regions in Central and Eastern Europe that started with

relatively low GDP per capita levels in 2000 (hence the large within group inequality), but caught up quickly over the last two decades; for those regions with a decreasing industry share, the tendency was more moderate.

It is worth noting that, regarding between-group inequalities, those groups of regions with an increasing industry share on average had rising GDP levels, whereas in those regions with a decreasing industry share, GDP levels declined. Thus, the mean relative income of urban regions with an increasing industry share rose from 1.24 in 2000 to 1.30 in 2019; this meant they were drawing away from the EU average GDP level. Both intermediate and rural regions that had an increasing industry share also saw a relative rise in their GDP levels: in the case of the intermediate regions, relative GDP increased from 0.87 to 0.98 from 2000 to 2019; meanwhile, relative GDP of the rural regions increased from 0.74 to 0.85. Consequently, both groups were strongly converging toward EU average GDP levels.

By contrast, in all regions with a declining industry share, relative GDP levels fell between 2000 and 2019. In the case of urban regions, GDP declined from 1.37 to 1.28; in intermediate regions - from 1.07 to 1.00; and in rural regions - from 0.93 to 0.85. Overall, this is a strong indication that industrial development - and, in the context of this study, exploitation of the benefits of globalisation - could be a key factor in economic growth.

Table 2. Regions by urbanisation and industry share: within-group inequality and relative mean incomes

	Manufacturing share	2000	2009	2019
Within-group inequality				
Urban	Decline	7.8	6.6	7.4
	Increase	13.3	10.0	9.0
Intermediate	Decline	7.5	5.6	5.6
	Increase	17.5	11.5	11.2
Rural	Decline	6.3	4.5	5.1
	Increase	15.5	9.1	8.4
Relative mean GDP per capita				
Urban	Decline	1.37	1.35	1.28
	Increase	1.24	1.27	1.30
Intermediate	Decline	1.07	1.04	1.00
	Increase	0.87	0.90	0.98
Rural	Decline	0.93	0.90	0.85
	Increase	0.74	0.79	0.85

Source: ARDECO, own calculations

Overall, the descriptive analysis suggests that those regions that manage to change their economic structure towards the production of tradables tend to have a growth advantage over regions that do not. Interestingly, this holds for all (i.e. urban, intermediate and rural) regions in a similar way. The point that these tradable sectors are subject to global competition indicates the relevance of policies that target the competitiveness of firms and regions alike.

6. The role of framework conditions

This section briefly discusses the role of three important factors for regional economic growth: (a) physical infrastructure, determining a region's accessibility; (b) institutional quality, measuring the quality of governance; and (c) a region's innovation potential. These three factors are considered to be important framework conditions for the prosperous economic development of EU regions. The three factors are represented by one index each – taken from the Regional Competitiveness Index (RCI), 2019 (Annoni & Dijkstra, 2019), where they are pillars of the overall index. Because of data limitations, the analysis in this section focuses on NUTS-2 regions only. In more detail, the indices are defined as follows:

- infrastructure is a summary score combining information from the following variables:
  - NUTS-2 population accessible within 1.5 hours by road, as a share of the population in a neighbourhood of 120 km radius, 2016;
  - NUTS-2 population accessible within 1.5 hours by rail (using optimal connections), as a share of the population in a neighbourhood of 120 km radius, 2014;
  - number of passenger flights (accessible within a drive of 1.5 hours) – daily number of passenger flights, 2016;
- institutional quality is a summary score of the indices:
  - corruption;
  - quality and accountability;
  - impartiality.

All three indices were estimated by the Quality of Government Institute (University of Gothenburg) (Charron *et al.*, 2019).

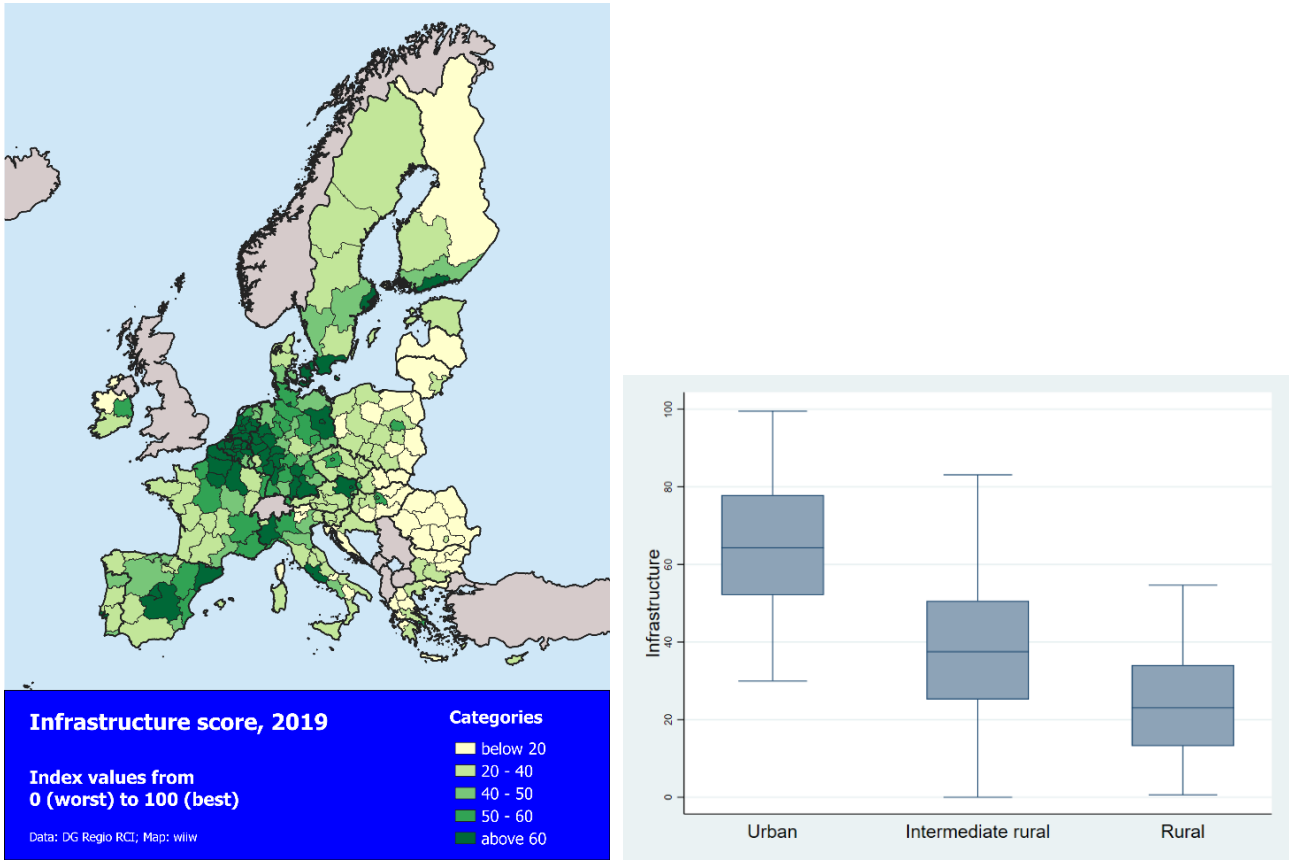
- Innovation is a summary score of the NUTS-2 regional variables:
  - core creativity class employment, % of population aged 15-64, average 2015-2017;

- knowledge workers, % of total employment average, average 2015-2017;
- scientific publications – number of publications per million inhabitants, average 2015-2017;
- total intramural research and development (R&D) expenditure, % of GDP, 2015;
- human resources in science and technology (HRST) in % of total employment, average 2015-2017;
- employment in technology and knowledge-intensive sectors, average 2015-2017;
- exports in medium-/high-technology products as a share of total product exports: measures the technological competitiveness of the EU, the ability to commercialise the results of R&D, 2017;
- sales of new-to-market and new-to-firm innovations as % of turnover: this captures both the creation of state-of-the-art technologies (new-to-market products) and the diffusion of these technologies (new-to-firm products), 2017.

The three framework variables are analysed for their regional distribution and their relation to economic growth.

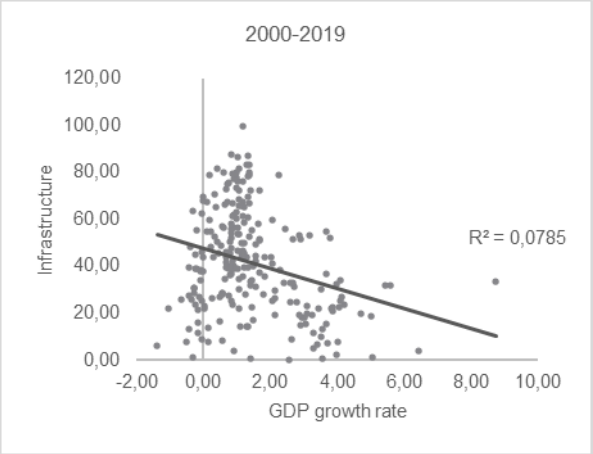
Starting with **infrastructure**, Figure 10 (left-hand map) illustrates highly uneven regional accessibility in the EU. On the one hand, regions in the centre of Europe, including Germany, the Benelux countries, France, Austria and Northern Italy, are highly accessible regions, whereas those in Southern and Eastern Europe are less accessible. Also, there is a strong differentiation between urban, intermediate and rural regions, as shown by both the left-hand map and the right-hand box plot in Figure 10. Thus, urban regions, on average, are much more readily accessible than intermediate regions, which, in turn, are more easily accessible than rural regions.

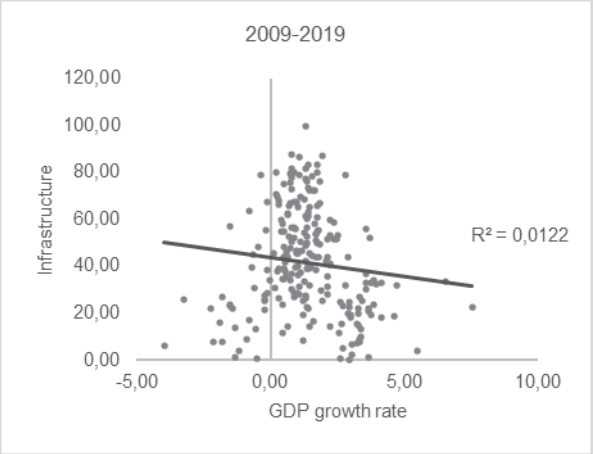
Figure 10. EU NUTS-2 regions – infrastructure score, from 0 (worst) to 100 (best)



If we consider the relationship to economic growth, Figure 11 suggests that there is little to no correlation between the NUTS-2 regions' infrastructure score and their GDP growth rates. Indeed, if there is any correlation at all, it is slightly negative, so that regions with lower accessibility showed higher growth rates in both periods 2000-2019 and 2009-2019. This counter-intuitive result hinges on the fact that, during these periods, the regions of Eastern Europe - which on average were less accessible than others - grew ahead of the other EU regions, thanks to a catch-up process.

Figure 11. Correlation: Infrastructure score and GDP growth rates, both in %; left-hand graph: 2000-2019, right-hand graph: 2009-2019

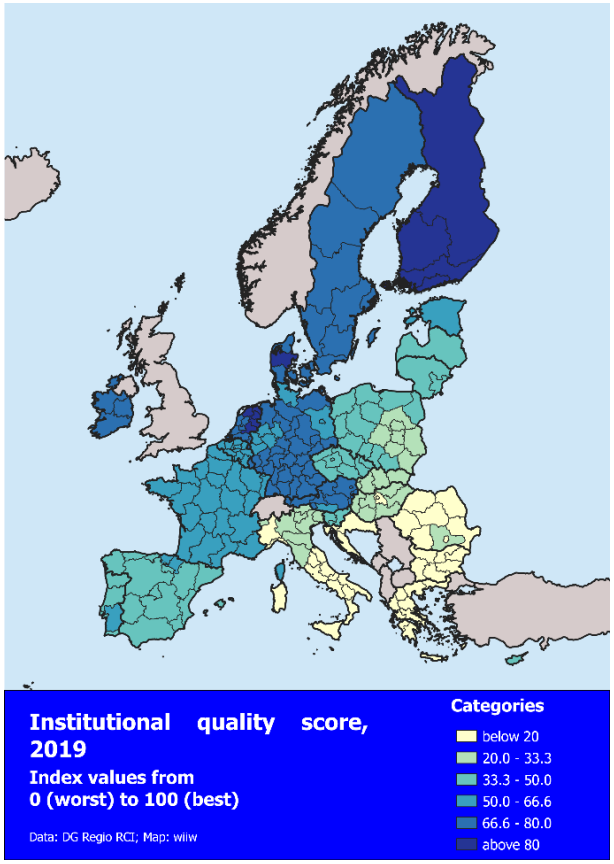




Source: DG Regio, RCI, own calculations

Turning to the **quality of institutions**, Figure 12 shows that this is mostly determined by the particular country, rather than by regional characteristics, as regions within a country tend to have more similar institution scores than regions across countries. Correspondingly, there is little difference in the quality of institutions between urban, intermediate and rural regions. This country-specific distribution of regional institutional quality leads to its low correlation with regional economic growth, as illustrated in Figure 13.

Figure 12. EU NUTS-2 regions institutions score, from 0 (worst) to 100 (best)



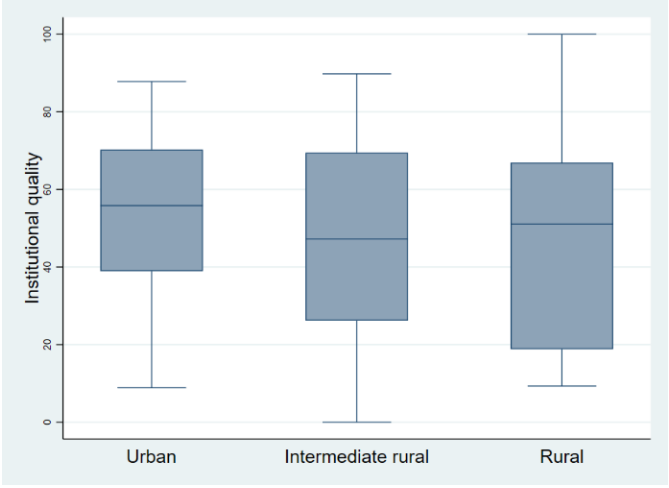
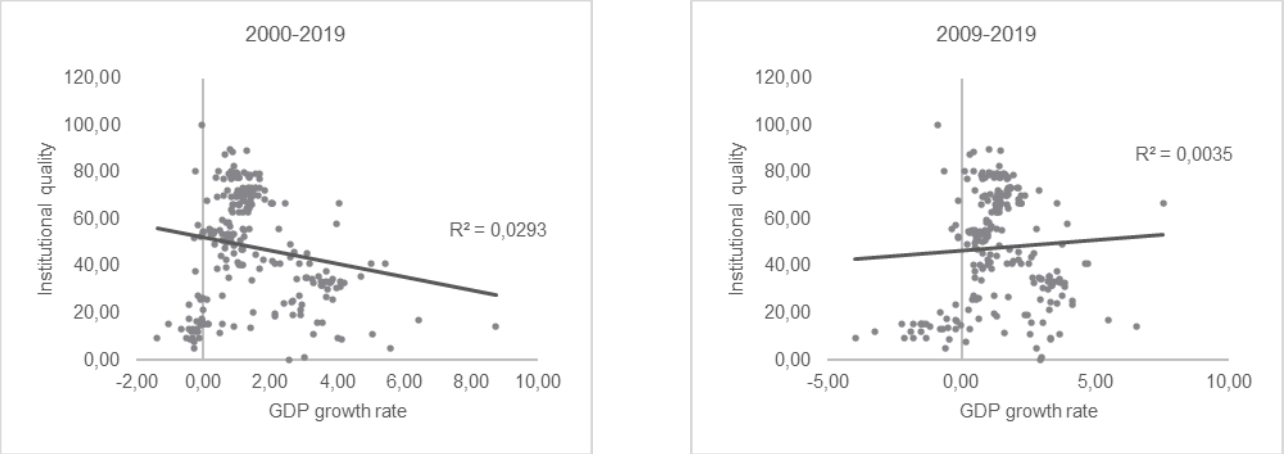


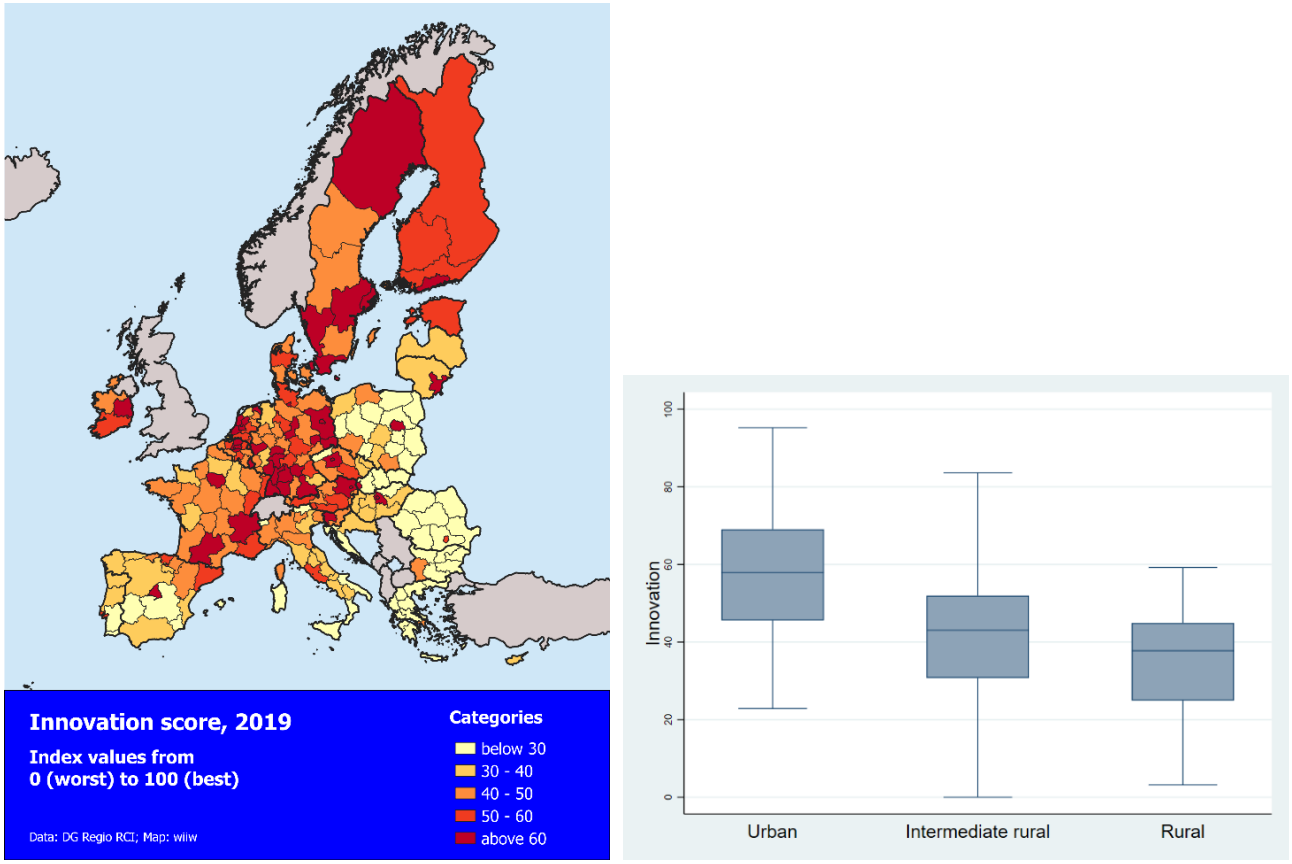
Figure 13. Correlation: Institutional quality score and GDP growth rates, both in %; left-hand graph: 2000-2019, right-hand graph: 2009-2019



Source: DG Regio RCI, own calculations

As far as the **innovation potential** is concerned, there is again more differentiation across EU regions. On the one hand, in Figure 14 (left-hand map) we observe a core-periphery pattern, as the EU core regions in Austria, France, Germany, the Benelux countries (but also Ireland and Scandinavia) have, on average, high innovation potential. By contrast, the peripheral EU regions (e.g. in Poland, Romania, Bulgaria, Greece, Southern Italy, Spain and Portugal) show low innovation potential. Simultaneously, the geographical distribution is also highly skewed towards urban regions (Figure 14, right-hand graph), which have a higher innovation potential than intermediate regions, whose potential is, in turn, higher than that of rural regions.

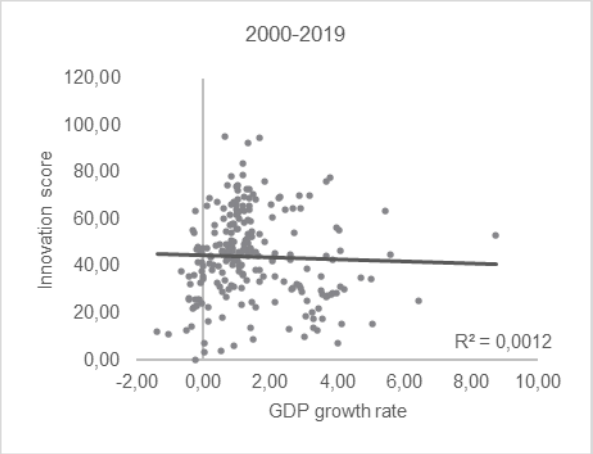
Figure 14. EU NUTS-2 regions innovation score, from 0 (worst) to 100 (best)

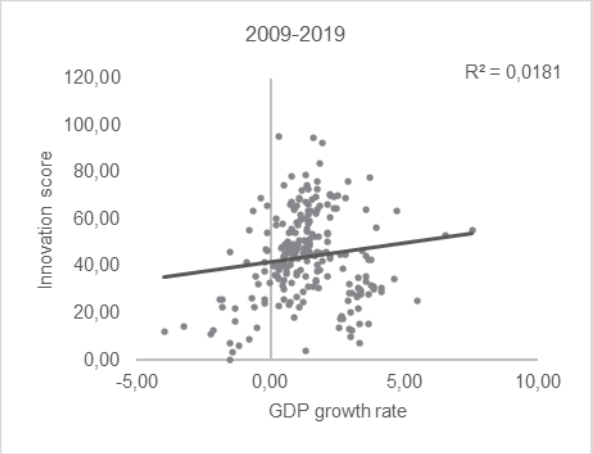


Regarding the correlation between innovation potential and regional economic growth, both graphs in Figure 15 suggest that there is little. The reasons for this are the same as in the case of accessibility. During the periods 2000-2019 and 2009-2019, the low innovation-potential regions in Eastern Europe outperformed all other regions in terms of GDP growth, which was mainly driven by a strong catch-up process.

Hence, at first sight, the data show no correlation of growth with any of the three framework conditions, which certainly confounds expectations and economic intuition. But as mentioned, the effects of these conditions on economic development might be concealed by the distinct development pattern of the Eastern European NUTS-2 regions. This requires more detailed analysis that allows such conditioning factors to be considered, as well as other explanatory variables. Hence, the next section is devoted to an econometric analysis of how structural change and globalisation, as well as institutions, infrastructure and innovation potential, affect regional economic growth in the EU.

Figure 15. Correlation: Innovation score and GDP growth rates, both in %; left-hand graph: 2000-2019, right-hand graph: 2009-2019





Source: DG Regio RCI, own calculations

7. Econometric analysis

In this section, we analyse the relation between globalisation, structural change and urban-rural economic polarisation in a more rigorous way. For this we use spatial econometrics to estimate which factors determine regional growth, with structural change being one of them. For the analysis, we estimate a spatial autoregressive model (SAR model) of the form:

$$Y = \rho \cdot WY + \beta \cdot X + \varepsilon$$

with $\varepsilon \sim N(0, \sigma^2)$.

Here, Y denotes average regional GDP growth for the EU over a certain period of time, $\rho \cdot WY$ is the spatially weighted GDP growth of neighbouring regions, i.e. an endogenous interaction effect. Furthermore, X is a matrix of covariates representing factors determining regional growth performance.

This regression set-up was chosen because EU regional data usually show a strong spatial dependence between regions. The presence of spatial effects was confirmed by ordinary least squares (OLS) estimations and subsequent Moran's I tests for spatial dependence. The choice of a SAR model was motivated by an economic point of view, as there are strong reasons to assume that the growth of a region is partly dependent on the economic performance of its neighbouring regions. Also, specification tests for the type of spatial dependence (Anselin & Bera, 1997) pointed in this direction.

To model the spatial dependence, we use a normalised distance-based spatial weight W matrix. Its elements w_{rj} are based on the geographical distance between regions r and j and are defined in the following way:

$$\begin{cases} w_{rj} = 1 \; if \; d_{rj} \leq d_j^*(k) \forall r, j = 1, \ldots, R; \; r \neq j \\ w_{rj} = 0 if \; d_{rj} > d_j^*(k), \end{cases}$$

where $d_j^*(k)$ is the cut-off distance beyond which developments in region j are assumed to have no effects on region r.

A fundamental aspect in the SAR model is the presence of spatial feedback loops. By way of illustration: a change in region r's growth affects, through spatial spill-overs, growth in the neighbouring regions. The additional growth in the neighbouring regions (caused by the initial growth in region r) feeds back again into the original region r, and so on. Thus, to estimate the growth effects correctly, these feedback loops must be considered. It is a similar story in the case of changes in investment in other regions: through spill-overs, investment in other regions affects developments in the original region, and these developments feed back again to the other regions, and so on.

The first feedback loop (emanating from changes in the original region) is usually understood as one involving direct effects, while the second feedback loop (effects from investment decisions concerning other regions) manifests itself as indirect effects. When added up, they result in the total effect of the regression variables.

Since we are interested in long-run growth dynamics, we estimate a cross-section model in two versions: the first covers the period 2000-2019; the second considers the economic crisis of 2008/2009 and covers the period 2009-2019. A comparison of the two models will indicate the extent to which the economic fallout from the crisis affected the growth prospects of the EU regions. Our main level of analysis is the regional NUTS-3 level. However, at this geographical level data availability is rather limited, particularly with respect to covariates. Therefore, we apply a hierarchical cross-section model. This allows the inclusion of NUTS-2 level characteristics in the NUTS-3 level model – and thus the inclusion of more explanatory variables that are assumed to be important for regional economic growth.

The hierarchical model includes the following NUTS-3 level covariates:

- initial levels of GDP per capita to account for neo-classical Solow growth model (Solow, 1956)-based convergence effects;

- the shares of agriculture, industry and advanced services (covering the NACE rev.2 sectors K to N) in a region's total gross value added, as well as the changes in the shares to model the sectoral specialisation of the regions and the potential effects of structural change;
- regional dummies for urban, intermediate rural and rural regions, to identify the growth differentials depending on the type of region.

Consequently, our model accounts for convergence across all NUTS-3 regions in Europe. The urban, intermediate rural and rural region dummies then control for whether one type of region has a 'natural' growth advantage over other types (i.e. a growth advantage that is not explained by other factors). It is not the aim of the analysis to estimate convergence within the urban, rural and intermediate rural groups of regions. In the analysis above, convergence has been found to occur within the groups, though it has no direct relevance to our research question and does not influence the results of the analysis. Though such group convergence is an interesting phenomenon, study of it must be deferred for future analysis.

The hierarchical model also includes the following NUTS-2 level variables, representing main factors of regional growth: investment, institutional quality, physical infrastructure , human capital and innovation potential.

Investment (i.e. gross fixed capital formation as a percentage of GDP) is included - as are the changes therein over the two periods - as it is an important factor (on both the demand and the supply sides) for the growth of regions. The data source for this variable is the ARDECO database.

The quality of institutions has been included, since numerous studies (e.g. Acemoglu *et al.*, 2005; Rodrik *et al.*, 2004; Charron *et al.*, 2012) show that economic growth and the well-being of a region's population depend on how a government delivers its policies. One important element is the role of government in reducing risk, as well as production and transactions costs (North, 1991).

Physical infrastructure, measuring both the digital and the physical accessibility of regions, has been included, because it can directly affect regional development through the reduction in transport and energy costs (Melo *et al.*, 2013). In macroeconomics, infrastructure is an important factor in technological progress (Aschauer, 1990). From the point of view of economic geography, it is an important factor for the formation of economic agglomerations (e.g. Fujita & Thisse, 1996). However, particularly the impact of physical infrastructure on regional

growth is disputed (Elburz *et al.*, 2017). Innovation potential is a well-known factor in economic growth and productivity and a 'key source of competitive advantage for territories and regions' (Crescenzi & Rodríguez-Pose, 2011).

The data for the quality of institutions, physical infrastructure and innovation potential are taken from the Regional Competitiveness Index (Annoni & Kozovska, 2010; Annoni & Dijkstra, 2019).

As an additional NUTS-2 covariate, we followed the endogenous growth theory and added the share of highly educated people (i.e. with completed tertiary education) in the total population as a factor representing the skill supply of the regions. The data source for this variable is the Eurostat regional statistics.

As in the descriptive analysis, at the level of NUTS-2 regions we added the share of agriculture, high- and low-technology-intensive manufacturing industries and knowledge-intensive services in total employment, as well as the respective changes over time as additional covariates. In the hierarchical model, they are used as an alternative to the sectoral NUTS-3 data to provide a more sectorally disaggregated view of the structural changes in EU regions (though at the cost of a more aggregated geographical perspective).

In addition, we include dummies for the three country groups, as defined in the descriptive analysis: EU-East, EU-South and EU-North.

7.1. Results

The hierarchical model was estimated for the full sample of regions, as well as for country-group sub-samples of regions (i.e. EU-East, EU-South and EU-North). Also, each estimation was done for the full period 2000-2019 and for the sub-period 2009-2019. Finally, we also included separate estimations depending on whether, as indicators of structural change, we used the less sectorally detailed NUTS-3 data or the more sectorally detailed NUTS-2 data (assuming the same values of those indicators for each NUTS-3 region within the respective NUTS-2 region).

As mentioned above, when including a spatially lagged dependent variable in the model, it is important for the interpretation of the estimated coefficients to consider both direct and indirect effects, as well as their sum (i.e. total effects). In this analysis, we are not too concerned with the actual size of parameter estimates, particularly as some of our explanatory variables are indices. Also, when comparing the initial SAR regression output and the subsequent estimation of (average) direct, indirect and total effects, we find that the significance of the explanatory variables rarely changes. And since presentation of the results detailing the direct, indirect and

total effects takes up a lot of space without adding very much to our interpretation of the results, we present them in the appendix, rather than in the main text. In the main text, we only present the standard regression results, as they are more familiar to the ordinary reader.

Starting with the econometric analysis of the full sample (see Table 3 and - in the appendix - Table 6), our estimation included 1,115 NUTS-3 regions in the period 2000-2019 and 1,152 NUTS-3 regions in the sub-period 2009-2019. The difference is due to missing data for some Croatian and Italian regions from 2000 to 2009. The results show the following: the estimated parameter for initial GDP is negative for the full period 2000-2019, as well as for the sub-period 2009-2019, indicating that GDP per capita levels, *ceteris paribus*, were converging. The change in the investment rate is insignificant over the full period, but does become significant in the period after the crisis. This indicates potential demand-side effects of investment, so that increases in (public or private) investment after the crisis led to higher regional growth. Also, the average investment rate is positively related to economic growth. This is interpreted as a supply-side effect, as regions with a higher investment rate on average accumulate more capital, thus expanding their production frontier.

Turning to the changes in the sectoral structure, it shows that an increase in the share of agriculture in GVA is associated with a lower regional growth rate. Most likely this is because an increasing agricultural share is brought about by a decline in the share of other (more productive) sectors of the economy (given that relatively unproductive sectors have more weight in the overall growth performance). As far as the agricultural employment share is concerned, that is also negatively associated with growth over the full period 2000-2019, but positively correlated in the sub-period. Regarding the structural change in industry, that is positively associated with regional economic growth in both the full and the sub-period. This is observed for both the NUTS-3 level change in industry's share in total GVA and the NUTS-2 level changes in employment shares in both the high- and the low-technology-intensive manufacturing sectors. Turning to the change in the share of services, it is - at least as far as the change in total GVA is concerned - insignificant over the full period and negatively related to growth in the sub-period 2009-2019. As far as employment shares are concerned, here we could focus explicitly on the knowledge intensive services (KIS): they show a positive correlation with regional economic growth.

Regarding the control variables, institutional quality, education and innovation are positively associated with regional growth, while the same goes for internet accessibility only in the sub-period 2009-2019. Physical accessibility is negatively related to economic growth, which may

be due to a local off-shoring of production from densely populated (and thus expensive) regions to less densely populated places.

As far as the urban and rural dummies are concerned (the intermediate group was used as a control), there is weak evidence that urban regions tend to have a growth advantage, while rural regions tend to be disadvantaged. However, these results are not robust over the models.

Turning to the country-group dummies (with the EU-North serving as control), these show that the EU-East had a clear growth advantage over the EU-North, while the advantage of the EU-South was much smaller and was also not robust over the different specifications.

Finally, the significant coefficient for spatially lagged GDP growth indicates the presence of spatial economic spill-overs across EU NUTS-3 regions.

Table 3. SAR results, hierarchical model, full sample, periods 2000-2019 and 2009-2019

VARIABLES	(1) GDP growth	(2) GDP growth	(3) GDP growth	(4) GDP growth
Group	ALL	ALL	ALL	ALL
Period	2000-2019	2000-2019	2009-2019	2009-2019
Initial GDP	-0.734***	-0.726***	-0.555***	-0.783***
	(0.0759)	(0.0757)	(0.103)	(0.107)
Investment rate change	-0.00284	-0.00118	0.0135*	0.0327***
	(0.00414)	(0.00427)	(0.00699)	(0.00754)
Average investment rate	0.0583***	0.0481***	0.0555***	0.0307***
	(0.00781)	(0.00812)	(0.0105)	(0.0119)
Agriculture, change in GVA share	-0.0735***		-0.154***	
	(0.0133)		(0.0240)	
Industry, change in GVA share	0.0269***		0.0885***	
	(0.00438)		(0.00761)	
Advanced services, change in GVA share	-0.00860		-0.0444***	
	(0.00714)		(0.0131)	
Agriculture, change in employment share		-0.0376***		0.0939***
		(0.0110)		(0.0202)
High-tech manufacturing, change in employment share		0.130***		0.357***
		(0.0243)		(0.0476)
Low-tech manufacturing, change in employment share		0.0361**		0.206***
		(0.0164)		(0.0443)
KIS, change in employment share		0.121***		0.144***
		(0.0188)		(0.0376)
Internet accessibility	-0.0256	0.286	3.159***	3.479***
	(0.475)	(0.485)	(0.620)	(0.665)
Institutional quality	0.0183***	0.0155***	0.0148***	0.0146***
	(0.00195)	(0.00199)	(0.00256)	(0.00287)
Physical infrastructure	-0.00512***	-0.00527***	-0.00818***	-0.00837***
	(0.00179)	(0.00182)	(0.00239)	(0.00263)
Innovation potential	0.00818***	0.00544**	0.00551*	0.00800**
	(0.00228)	(0.00233)	(0.00315)	(0.00345)
Highly educated, share	0.00883**	0.0152***	0.0195***	0.0114*
	(0.00387)	(0.00390)	(0.00552)	(0.00624)
Urban dummy	0.290***	0.215***	0.139*	0.0279
	(0.0637)	(0.0636)	(0.0845)	(0.0916)
Rural dummy	-0.108**	-0.0826	-0.201***	-0.112
	(0.0514)	(0.0511)	(0.0663)	(0.0727)
South dummy	0.221**	0.0467	0.415***	0.0363
	(0.0994)	(0.0988)	(0.129)	(0.140)
East dummy	1.786***	1.557***	1.632***	1.350***
	(0.134)	(0.138)	(0.154)	(0.178)
Spatially lagged growth	0.323***	0.410***	0.467***	0.607***
	(0.0859)	(0.0898)	(0.0928)	(0.0989)
Constant	5.259***	5.034***	0.716	3.478***
	(0.780)	(0.796)	(1.036)	(1.128)
Observations*	1,115	1,115	1,152	1,152

**Note:* For reasons of data availability, estimations (1) and (2) exclude some Croatian and Italian regions.
*** indicate a 0,001 level of significance, ** a 0,05 level of significance.

Turning to the country-group sub-sample estimations, the most important results are as follows (see **Table *1*** and **Table *2*** below, as well as **Table *3*** and **Table *4*** in the appendix).

Convergence of GDP per capita levels is observed for all three country groups individually, over both the full and the sub-period. The change in the investment rate is only positively associated with regional economic growth in EU-North NUTS-3 regions; meanwhile, for EU-East regions there is a negative correlation. Interestingly, the average investment rate is positively related to growth in both the EU-North and the EU-East regions, though in the former this is only observed for the full sample, whereas for the latter it is also valid for the sub-sample 2009-2019. There is no correlation with regional growth in the EU-South regions.

As far as changes in the sectoral structure are concerned, the change in the share of industry in total GVA is positively associated with growth only in the EU-North, while there is a negative correlation in the EU-East. The more detailed employment shares reveal that in the EU-North, both the high- and the low-technology-intensive manufacturing sectors have positive effects on economic growth, whereas in the EU-East this applies only to the high-technology-intensive manufacturing sector.

At a more detailed sectoral level in all three country groups an employment shift to KIS is positively related to regional GDP growth. Yet this only holds for the full period, indicating that after the crisis these services lost steam in generating growth.

Concerning the framework conditions, the results indicate that institutional quality is an important precondition for growth in all three country groups. By comparison, innovation potential is only important for growth in the EU-South and the EU-North regions, in particular after the crisis of 2008/2009. There is no correlation with growth in the EU-East, suggesting that these regions may have a growth model that differs from other EU regions (i.e. one that is not necessarily driven by domestic knowledge).

Regarding degree of urbanisation, the results suggest that only in the EU-East do urban regions have a significant growth advantage and rural regions a disadvantage: growth there was focused on the highly urbanised regions. In the EU-North and EU-South, the degree of urbanisation was not a determinant for the level of economic growth. Finally, economic spill-overs are only significantly positive for the EU-North and the EU-East.

Table 4. SAR results, hierarchical model, sub-samples, period 2000-2019

VARIABLES	(1) GDP growth	(2) GDP growth	(3) GDP growth	(4) GDP growth	(5) GDP growth	(6) GDP growth
Group	SOUTH	NORTH	EAST	SOUTH	NORTH	EAST
Period	2000-2019	2000-2019	2000-2019	2000-2019	2000-2019	2000-2019
Initial GDP	-1.275***	-0.320***	-0.963***	-1.060***	-0.391***	-1.279***
	(0.204)	(0.0657)	(0.244)	(0.213)	(0.0776)	(0.218)
Investment rate change	0.0164	0.00740**	-0.0371***	-0.00402	0.0127***	-0.0866***
	(0.0128)	(0.00364)	(0.0128)	(0.0139)	(0.00485)	(0.0122)
Average investment rate	-0.0167	0.0314***	0.0770***	-0.00429	0.0278***	0.0564***
	(0.0222)	(0.00780)	(0.0214)	(0.0218)	(0.0104)	(0.0199)
Agriculture, change in GVA share	-0.0125	-0.102***	-0.0254			
	(0.0221)	(0.0268)	(0.0230)			
Industry, change in GVA share	0.0117	0.0777***	-0.0182*			
	(0.0108)	(0.00436)	(0.0103)			
Advanced services, change in GVA share	-0.00702	0.0428***	-0.0995***			
	(0.0182)	(0.00637)	(0.0198)			
Agriculture, change in employment share				-0.0600**	-0.00203	-0.0726***
				(0.0276)	(0.0425)	(0.0177)
High-tech manufacturing, change in employment share				0.154	0.143***	0.114**
				(0.0984)	(0.0318)	(0.0463)
Low-tech manufacturing, change in employment share				0.00616	0.131***	-0.0147
				(0.0279)	(0.0272)	(0.0402)
KIS, change in employment share				0.118*	0.0634**	0.144***
				(0.0609)	(0.0259)	(0.0491)
Internet accessibility	1.815**	-0.409	-1.996	2.544***	-2.117***	2.597
	(0.819)	(0.603)	(1.684)	(0.833)	(0.764)	(1.591)
Institutional quality	0.0286***	0.0181***	0.0122	0.0223***	0.0190***	0.0121*
	(0.00584)	(0.00177)	(0.00744)	(0.00594)	(0.00238)	(0.00727)
Physical infrastructure	0.00222	-0.000800	-0.0360***	-0.000281	-0.00212	-0.0201**
	(0.00419)	(0.00144)	(0.00819)	(0.00421)	(0.00178)	(0.00818)
Innovation potential	0.0106*	0.00286	0.0102	0.00277	0.00522**	-0.0147
	(0.00573)	(0.00188)	(0.00893)	(0.00683)	(0.00228)	(0.00998)
Highly educated, share	0.0134*	0.00366	0.0361***	0.0279***	-0.00212	0.0480***
	(0.00717)	(0.00394)	(0.0100)	(0.00832)	(0.00570)	(0.00938)
Urban dummy	0.00878	0.0712	1.126***	0.0109	0.0459	1.101***
	(0.124)	(0.0515)	(0.245)	(0.122)	(0.0619)	(0.232)
Rural dummy	0.114	-0.0570	-0.292**	0.163*	0.0347	-0.437***
	(0.102)	(0.0439)	(0.132)	(0.0986)	(0.0536)	(0.129)
South dummy	0.0629	0.362***	0.352***	-0.0219	0.139	0.304***
	(0.264)	(0.0795)	(0.105)	(0.283)	(0.103)	(0.109)
East dummy	10.23***	2.170**	10.05***	7.010***	4.909***	9.293***
	(1.804)	(0.916)	(1.954)	(2.039)	(1.103)	(1.850)
Spatially lagged growth	169	728	218	169	728	218
	-1.275***	-0.320***	-0.963***	-1.060***	-0.391***	-1.279***
Constant	(0.204)	(0.0657)	(0.244)	(0.213)	(0.0776)	(0.218)
	0.0164	0.00740**	-0.0371***	-0.00402	0.0127***	-0.0866***
Observations*	(0.0128)	(0.00364)	(0.0128)	(0.0139)	(0.00485)	(0.0122)

Note: *** indicate a 0,001 level of significance, ** a 0,05 level of significance.
'EU-East' includes all NUTS-3 regions in Bulgaria, Croatia, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia. 'EU-South' includes regions in Cyprus, Malta, Portugal and Spain, as well as Southern Italy.
'EU-North' includes regions in Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Northern Italy, Luxembourg, the Netherlands and Sweden.

Table 5. SAR results – hierarchical model, sub-samples, period 2009-2019

VARIABLES	(1) GDP growth	(2) GDP growth	(3) GDP growth	(4) GDP growth	(5) GDP growth	(6) GDP growth
Group	SOUTH	NORTH	EAST	SOUTH	NORTH	EAST
Period	2009-2019	2009-2019	2009-2019	2009-2019	2009-2019	2009-2019
Initial GDP	-1.068***	-0.250***	-0.467*	-1.043***	-0.396***	-0.998***
	(0.330)	(0.0908)	(0.274)	(0.357)	(0.116)	(0.269)
Investment rate change	0.0339*	0.0363***	-0.0361**	0.0139	0.0511***	-0.0444***
	(0.0174)	(0.00657)	(0.0155)	(0.0174)	(0.00928)	(0.0159)
Average investment rate	0.0480	0.0107	0.117***	-0.0121	0.0204	0.0762***
	(0.0347)	(0.00989)	(0.0257)	(0.0389)	(0.0148)	(0.0275)
Agriculture, change in GVA share	-0.0477	-0.201***	-0.0978***			
	(0.0471)	(0.0401)	(0.0372)			
Industry, change in GVA share	0.00715	0.155***	-0.00757			
	(0.0246)	(0.00688)	(0.0155)			
Advanced services, change in GVA share	-0.144***	0.0448***	-0.182***			
	(0.0392)	(0.0115)	(0.0320)			
Agriculture, change in employment share				-0.0821	-0.0394	0.0119
				(0.0667)	(0.0971)	(0.0323)
High-tech manufacturing, change in employment share				0.244	0.175***	0.262***
				(0.241)	(0.0670)	(0.0726)
Low-tech manufacturing, change in employment share				-0.332***	0.190***	0.0362
				(0.121)	(0.0585)	(0.0877)
KIS, change in employment share				0.114	-0.00490	0.00207
				(0.107)	(0.0485)	(0.0901)
Internet accessibility	6.302***	-0.521	1.440	6.133***	-1.473	5.879***
	(1.449)	(0.803)	(2.022)	(1.491)	(1.125)	(2.002)
Institutional quality	0.0527***	0.0152***	0.0274***	0.0413***	0.0125***	0.0162*
	(0.00776)	(0.00226)	(0.00879)	(0.00839)	(0.00339)	(0.00960)
Physical infrastructure	-0.00513	-0.00402**	-0.0418***	0.00172	-0.00658**	-0.0280***
	(0.00625)	(0.00195)	(0.00949)	(0.00651)	(0.00269)	(0.0104)
Innovation potential	0.0242***	0.00439*	-0.00817	0.0114	0.0114***	-0.0183
	(0.00821)	(0.00258)	(0.0113)	(0.0101)	(0.00360)	(0.0127)
Highly educated, share	-0.0368***	0.00820	0.0762***	-0.0214	-0.00665	0.104***
	(0.0106)	(0.00533)	(0.0151)	(0.0138)	(0.00819)	(0.0166)
Urban dummy	-0.0405	-0.0160	0.402	-0.103	-0.0477	0.211
	(0.177)	(0.0701)	(0.289)	(0.180)	(0.0947)	(0.306)
Rural dummy	0.0657	-0.0891	-0.528***	0.178	0.0208	-0.398**
	(0.151)	(0.0590)	(0.146)	(0.153)	(0.0812)	(0.163)
South dummy	-0.192	0.280***	0.791***	0.223	0.385***	0.755***
	(0.203)	(0.0837)	(0.103)	(0.216)	(0.114)	(0.117)
East dummy	3.623	2.141*	-0.0681	3.748	4.974***	1.805
	(2.939)	(1.183)	(2.469)	(3.193)	(1.569)	(2.525)
Spatially lagged growth	169	744	239	169	744	239
	-1.068***	-0.250***	-0.467*	-1.043***	-0.396***	-0.998***
Constant	(0.330)	(0.0908)	(0.274)	(0.357)	(0.116)	(0.269)
	0.0339*	0.0363***	-0.0361**	0.0139	0.0511***	-0.0444***
Observations*	(0.0174)	(0.00657)	(0.0155)	(0.0174)	(0.00928)	(0.0159)

Note: *** indicate a 0,001 level of significance, ** a 0,05 level of significance.
'EU-East' includes all NUTS-3 regions in Bulgaria, Croatia, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia.
'EU-South' includes regions in Cyprus, Malta, Portugal and Spain, as well as Southern Italy.
'EU-North' includes regions in Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Northern Italy, Luxembourg, the Netherlands and Sweden.

8. Summary and conclusions

We started this analysis on the back of our research question: 'Does globalisation-related structural change increase the economic polarisation between urban and rural NUTS-3 regions in the EU?' In the light of our results, we can answer that question thus: No it does not. Or - to be precise - it has not done so in the past.

First, the analysis showed that GDP per capita levels in urban regions tend to be on average 30% higher than in rural regions. Thus, there are significant differences in economic prosperity between different types of regions. In practice, the actual differences in living standards between urban and rural regions might be smaller than suggested by the differences in the level of GDP per capita, due to headquarters[6] and commuting[7] effects. Still, these differences are likely to be intrinsic and caused by agglomeration externalities, leading to a typical core-periphery pattern of economic development that is well known from the new economic geography literature.

Yet, our results show that throughout the period 2000-2019, these differences became smaller. GDP per capita levels in NUTS-3 regions converged – even though the process slowed after the 2008/2009 crisis and even though there was a marked tendency toward group convergence, as GDP levels converged within the urban, intermediate and rural groups of regions, but only moderately between those groups. Thus, at an aggregate EU level, there was no indication of any increase in the polarisation of GDP per capita levels. Nevertheless, at the level of country groups - and specifically the EU-East - we found that urban regions have a growth advantage over rural regions. This was not the case in the EU-South or EU-North.

Second, concerning the growth effects of globalisation-related structural change, our results indicate that it may have contributed to a reduction in regional GDP per capita disparities, rather than to an increase in economic polarisation. This is because the analysis highlights the importance for regional economic growth of industrial development, specifically in high-tech-intensive manufacturing industries and knowledge-intensive services. This effect is not restricted to particular types of NUTS-3 regions, but applies equally to urban, intermediate and rural regions.

[6] These arise if much of the production of a geographically dispersed company is accounted for by the headquarters, and thus occurs in the region where it the headquarters are located.
[7] These arise because in regional accounts the output of workers commuting from region A to region B is attributed to the latter, i.e. the place of work, rather than where they live – and where they spend most of their income.

From this result, we may deduce a recipe for regional growth and development, particularly for less-developed regions: to support and develop the tradable sector.. These form the economic base upon which all other economic activities in the regions rely; and the bigger the tradable sector is, the larger the surrounding sectors will grow.

This is easier said than done, though. First, it requires a non-negligible number of preconditions: high institutional quality, an adequate skill supply, (digital) infrastructure and innovation potential. Importantly, it also requires major investment in a region's production capital, with the aim of achieving short-term demand effects during a crisis and long-term capacity effects capable of boosting that region's potential output. The dilemma facing the less-developed, very often rural or intermediate regions is that the preconditions they face are more onerous than in other regions, which reduces their attractiveness to investors. This leaves a sizeable space to be filled by economic policy at all levels of government.

At the European level, EU cohesion policy is the main tool for supporting economic development, particularly in the least-developed regions. There is no doubt that, for those regions, EU cohesion policy is extremely important: first, on account of its scale - EU support in the least-developed regions may well reach 2.5% or more of their annual GDP (Römisch, 2020); and secondly, because - in the absence of regional policies at the country level - it is often the only regional policy tool available to those regions (Jestl & Römisch, 2017). Nevertheless, EU cohesion policy faces certain dilemmas. First, the extent to which this policy can counter market forces like agglomeration externalities to develop higher value-added sectors in less-developed regions remains an open question. If those market forces are strong, then 'forcing' a structural change in a disadvantaged region could result in very inefficient regional policy, particularly if such policy fails to take account of the differences in the basic characteristics of regions.

Partly because of that, place-based approaches have become more popular in EU regional policy, where development that draws on the strengths of the regions should be supported. The expectation is that incomes in those regions - and consequently quality of life there - will rise. On the flip side, however, it potentially also means that the fundamental differences in levels of GDP per capita will not disappear, as some regions will continue to specialise in high value-added activities, while others will focus on lower value-added activities.

This can certainly be assumed for existing branches of the economy, where existing geographical location patterns, value-added chains and the associated economic and geographical externalities (such as a labour market and education system to support a specific branch) are well established and difficult to override.

But also establishing new branches in less-developed regions may be difficult for EU cohesion policy. New branches are more dynamic and geographically footloose, in the sense that they are less bound by tradition to specific regions. Thus they can, in principle, be developed anywhere. These could include renewable energy production, plus the necessary technical equipment, branches of the circular economy or branches formerly outsourced to low-wage countries.

One difficulty is that these branches, too, even if they are more footloose, most likely prefer regions with good transport, digital or energy infrastructure, a good educational system and qualified labour supply, existing support services, and stable and reliable government. The problem with less-developed regions is that with respect to many of those factors, their endowments are worse than in more-developed regions. The challenge for EU cohesion policy is that, in order to make those regions more attractive for investment, their many disadvantages need to be tackled simultaneously – for example, creating a strong educational system in a peripheral region, without also making sure that that region is more accessible to the outside, may not improve its competitive position by much. This challenge could be tackled by allowing for integrated approaches in EU cohesion policy that address multiple regional weaknesses in a coordinated way. That could increase policy efficiency and raise the potential of less-developed regions to prosper economically and catch up with more-developed regions.

To be effective, EU cohesion policy needs to be supported by national and local policymaking. At the national level, governments seeking territorial development could focus on location and industrial policies. On the one hand, location policies could be run through the central budget (e.g. by building infrastructure, supporting firms or specific industries – assuming that is in line with EU regulations) or via the tax regime (by setting lower tax rates for firms in less-developed regions, or offering other tax incentives). Moreover, central government can use its regulatory power for territorial development. This could include settlement policies (e.g. creating local centres in less-developed regions that would act as magnets for agglomeration externalities), education policies or labour market policies (e.g. increasing labour mobility).

Policymakers at the local level have the best perspective on the characteristics of a particular region, and thus should be the starting point for any place-based policy approaches. The aim of these approaches should be to make use of local comparative advantages, and to develop those sectors and branches that rely on them. However, one major issue here is that the local capacity for policymaking (in terms of the number of staff available for analysis and planning) is often inadequate (and the lower the level of government, the bigger the problem), while at the same

time local policy competencies and finances might not be sufficient to engage in any significant local development policy (Fornoni *et al.*, 2017).

Thus, overall supporting structural change, especially in the least-developed regions, is a challenging business and relies on different layers of policymaking – from the supranational EU down to the local level. Thereby, very often different layers and different policies (and different policies at different layers) interfere with each other, reducing the effectiveness of any regional development policy. This makes policy coordination all the more important.

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Appendix

Table 6. Direct, indirect and total effects, full sample, periods 2000-2019 and 2009-2019

	ALL 2000-2019		ALL 2000-2019		ALL 2009-2019		ALL 2009-2019	
Direct effects								
Initial GDP	-0.734	***	-0.727	***	-0.556	***	-0.784	***
Investment rate change	-0.003		-0.001		0.014	*	0.033	***
Average investment rate	0.058	***	0.048	***	0.056	***	0.031	**
Agriculture, change in GVA share	-0.074	***			-0.154	***		
Industry, change in GVA share	0.027	***			0.089	***		
Advanced services, change in GVA share	-0.009				-0.044	***		
Agriculture, change in employment share			-0.038	***			0.094	***
High-tech manuf., change in employment share			0.130	***			0.357	***
Low-tech manuf., change in employment share			0.036	**			0.206	***
KIS, change in employment share			0.121	***			0.144	***
Internet accessibility	-0.026		0.286		3.161	***	3.484	***
Institutional quality	0.018	***	0.016	***	0.015	***	0.015	***
Physical infrastructure	-0.005	***	-0.005	***	-0.008	***	-0.008	***
Innovation potential	0.008	***	0.005	**	0.006	*	0.008	**
Highly educated, share	0.009	**	0.015	***	0.020	***	0.011	*
Urban dummy	0.290	***	0.215	***	0.139		0.028	
Rural dummy	-0.108	**	-0.083		-0.201	***	-0.112	
South dummy	0.221	**	0.047		0.415	***	0.036	
East dummy	1.787	***	1.558	***	1.633	***	1.352	***
Indirect effects								
Initial GDP	-0.271	**	-0.389	**	-0.377	**	-0.927	**
Investment rate change	-0.001		-0.001		0.009		0.039	**
Average investment rate	0.022	**	0.026	**	0.038	**	0.036	*
Agriculture, change in GVA share	-0.027	**			-0.105	***		
Industry, change in GVA share	0.010	**			0.060	***		
Advanced services, change in GVA share	-0.003				-0.030	**		
Agriculture, change in employment share			-0.020	*			0.111	**
High-tech manuf., change in employment share			0.070	***			0.423	**
Low-tech manuf., change in employment share			0.019	*			0.243	**
KIS, change in employment share			0.065	**			0.171	**
Internet accessibility	-0.009		0.153		2.145	**	4.122	*
Institutional quality	0.007	***	0.008	***	0.010	***	0.017	***
Physical infrastructure	-0.002	*	-0.003	*	-0.006	*	-0.010	*
Innovation potential	0.003	**	0.003	*	0.004		0.009	*
Highly educated, share	0.003		0.008	**	0.013	*	0.014	
Urban dummy	0.107	**	0.115	**	0.094		0.033	
Rural dummy	-0.040	*	-0.044		-0.136	**	-0.133	
South dummy	0.082		0.025		0.282	*	0.043	
East dummy	0.660	***	0.834	***	1.108	***	1.599	**
Total effects								
Initial GDP	-1.006	***	-1.116	***	-0.933	***	-1.711	***
Investment rate change	-0.004		-0.002		0.023	*	0.072	***
Average investment rate	0.080	***	0.074	***	0.093	***	0.067	**
Agriculture, change in GVA share	-0.101	***			-0.259	***		
Industry, change in GVA share	0.037	***			0.149	***		
Advanced services, change in GVA share	-0.012				-0.075	***		
Agriculture, change in employment share			-0.058	***			0.205	***
High-tech manuf., change in employment share			0.199	***			0.780	***

	ALL 2000-2019		ALL 2000-2019		ALL 2009-2019		ALL 2009-2019	
Low-tech manuf., change in employment share			0.055	**			0.449	***
KIS, change in employment share			0.186	***			0.315	***
Internet accessibility	-0.035		0.440		5.306	***	7.606	***
Institutional quality	0.025	***	0.024	***	0.025	***	0.032	***
Physical infrastructure	-0.007	**	-0.008	**	-0.014	***	-0.018	**
Innovation potential	0.011	***	0.008	**	0.009	*	0.018	**
Highly educated, share	0.012	**	0.023	***	0.033	***	0.025	
Urban dummy	0.397	***	0.331	***	0.233		0.061	
Rural dummy	-0.148	**	-0.127		-0.338	***	-0.245	
South dummy	0.303	**	0.072		0.697	***	0.079	
East dummy	2.447	***	2.391	***	2.742	***	2.950	***

Table 7. Direct, indirect and total effects, country sub-samples, period 2000-2019

	SOUTH 2000-2019	NORTH 2000-2019	EAST 2000-2019	SOUTH 2000-2019	NORTH 2000-2019	EAST 2000-2019
Direct effects						
Initial GDP	-1.275 ***	-0.32 ***	-0.965 ***	-1.06 ***	-0.391 ***	-1.281 ***
Investment rate change	0.0164	0.0074 **	-0.0372 ***	-0.00402	0.0127 ***	-0.0868 ***
Average investment rate	-0.0167	0.0314 ***	0.0772 ***	-0.00429	0.0278 ***	0.0565 ***
Agriculture, change in GVA share	-0.0125	-0.102 ***	-0.0255			
Industry, change in GVA share	0.0117	0.0778 ***	-0.0182 *			
Advanced services, change in GVA share	-0.00702	0.0429 ***	-0.0997 ***			
Agriculture, change in employment share				-0.06 **	-0.00203	-0.0727 ***
High-tech manuf., change in employ. share				0.154	0.143 ***	0.115 **
Low-tech manuf., change in employ. share				0.00616	0.131 ***	-0.0147
KIS, change in employment share				0.118 *	0.0634 **	0.144 ***
Internet accessibility	1.815 **	-0.409	-2	2.544 ***	-2.117 ***	2.601
Institutional quality	0.0286 ***	0.0181 ***	0.0122	0.0223 ***	0.019 ***	0.0121 *
Physical infrastructure	0.00222	-0.0008	-0.036 ***	-0.000281	-0.00212	-0.0201 **
Innovation potential	0.0106 *	0.00286	0.0102	0.00277	0.00522 **	-0.0147
Highly educated, share	0.0134 *	0.00366	0.0362 ***	0.0279 ***	-0.00212	0.0481 ***
Urban dummy	0.00878	0.0712	1.128 ***	0.0109	0.0459	1.102 ***
Rural dummy	0.114	-0.057	-0.293 **	0.163 *	0.0347	-0.438 ***
Indirect effects						
Initial GDP	-0.0634	-0.154 **	-0.483 **	0.0171	-0.0539	-0.518 *
Investment rate change	0.000815	0.00357	-0.0186 *	0.000065	0.00175	-0.0351 **
Average investment rate	-0.00083	0.0151 **	0.0386 *	0.0000694	0.00383	0.0229
Agriculture, change in GVA share	-0.00062	-0.0491 **	-0.0128			
Industry, change in GVA share	0.000583	0.0375 ***	-0.00912			
Advanced services, change in GVA share	-0.000349	0.0207 **	-0.0499 **			
Agriculture, change in employment share				0.000969	-0.00028	-0.0294 *
High-tech manuf., change in employ. share				-0.00249	0.0197	0.0464 *
Low-tech manuf., change in employ. share				-0.0000996	0.018	-0.00596
KIS, change in employment share				-0.0019	0.00874	0.0584 **
Internet accessibility	0.0903	-0.197	-1.001	-0.0411	-0.292	1.052
Institutional quality	0.00142	0.00874 ***	0.0061	-0.000361	0.00261	0.00489
Physical infrastructure	0.000111	-0.000386	-0.018 *	0.00000454	-0.000292	-0.00814
Innovation potential	0.000525	0.00138	0.00511	-0.0000447	0.00072	-0.00594
Highly educated, share	0.000664	0.00176	0.0181	-0.00045	-0.000292	0.0194
Urban dummy	0.000437	0.0343	0.564 **	-0.000176	0.00632	0.446 **
Rural dummy	0.00567	-0.0275	-0.147 *	-0.00264	0.00478	-0.177 *

	SOUTH 2000-2019		NORTH 2000-2019		EAST 2000-2019		SOUTH 2000-2019		NORTH 2000-2019		EAST 2000-2019	
Total effects												
Initial GDP	-1.339	***	-0.474	***	-1.448	***	-1.043	***	-0.445	***	-1.799	***
Investment rate change	0.0172		0.011	*	-0.0558	***	-0.00396		0.0144	**	-0.122	***
Average investment rate	-0.0175		0.0466	***	0.116	***	-0.00422		0.0316	**	0.0794	**
Agriculture, change in GVA share	-0.0131		-0.151	***	-0.0382							
Industry, change in GVA share	0.0123		0.115	***	-0.0273	*						
Advanced services, change in GVA share	-0.00737		0.0635	***	-0.15	***						
Agriculture, change in employment share							-0.059	**	-0.00231		-0.102	***
High-tech manuf., change in employ. share							0.152		0.163	***	0.161	**
Low-tech manuf., change in employ. share							0.00606		0.149	***	-0.0207	
KIS, change in employment share							0.116	*	0.0722	**	0.203	***
Internet accessibility	1.906	**	-0.607		-3.001		2.503	***	-2.408	***	3.653	
Institutional quality	0.03	***	0.0269	***	0.0183		0.022	***	0.0216	***	0.017	
Physical infrastructure	0.00233		-0.00119		-0.0541	***	-0.000276		-0.00241		-0.0283	**
Innovation potential	0.0111	*	0.00424		0.0153		0.00272		0.00594	**	-0.0206	
Highly educated, share	0.014	*	0.00542		0.0543	***	0.0274	***	-0.00241		0.0675	***
Urban dummy	0.00922		0.106		1.692	***	0.0107		0.0522		1.548	***
Rural dummy	0.12		-0.0845		-0.44	**	0.161		0.0394		-0.615	***

Note: *** indicate a 0,001 level of significance, ** a 0,05 level of significance

Table 8. Direct, indirect and total effects, country sub-samples, period 2009-2019

	SOUTH 2009-2019		NORTH 2009-2019		EAST 2009-2019		SOUTH 2009-2019		NORTH 2009-2019		EAST 2009-2019	
Direct effects												
Initial GDP	-1.068	***	-0.25	***	-0.476	*	-1.044	***	-0.396	***	-1.014	***
Investment rate change	0.0339	*	0.0364	***	-0.0368	**	0.0139		0.0511	***	-0.0451	***
Average investment rate	0.048		0.0107		0.119	***	-0.0122		0.0204		0.0774	***
Agriculture, change in GVA share	-0.0477		-0.201	***	-0.0996	***						
Industry, change in GVA share	0.00715		0.155	***	-0.00771							
Advanced services, change in GVA share	-0.144	***	0.0448	***	-0.186	***						
Agriculture, change in employment share							-0.0822		-0.0394		0.0121	
High-tech manuf., change in employ. share							0.244		0.175	***	0.266	***
Low-tech manuf., change in employ. share							-0.332	***	0.191	***	0.0368	
KIS, change in employment share							0.114		-0.0049		0.0021	
Internet accessibility	6.306	***	-0.522		1.467		6.139	***	-1.474		5.969	***
Institutional quality	0.0527	***	0.0152	***	0.0279	***	0.0413	***	0.0125	***	0.0165	*
Physical infrastructure	-0.00513		-0.00403	**	-0.0426	***	0.00172		-0.00659	**	-0.0284	***
Innovation potential	0.0242	***	0.00439	*	-0.00832		0.0114		0.0114	***	-0.0186	
Highly educated, share	-0.0368	***	0.0082		0.0776	***	-0.0214		-0.00665		0.105	***
Urban dummy	-0.0405		-0.016		0.41		-0.103		-0.0478		0.215	
Rural dummy	0.0657		-0.0891		-0.537		0.178		0.0208		-0.404	**
Indirect effects												
Initial GDP	0.134		-0.0827	*	-1.624		-0.213		-0.21	*	-2.836	
Investment rate change	-0.00424		0.012	**	-0.125		0.00283		0.0271	*	-0.126	
Average investment rate	-0.00601		0.00355		0.407		-0.00248		0.0109		0.216	
Agriculture, change in GVA share	0.00597		-0.0664	**	-0.34							
Industry, change in GVA share	-0.000896		0.0515	**	-0.0263							
Advanced services, change in GVA share	0.018		0.0148	*	-0.634							
Agriculture, change in employment share							-0.0167		-0.0209		0.0339	
High-tech manuf., change in employ. share							0.0497		0.0928	*	0.745	
Low-tech manuf., change in employ. share							-0.0676		0.101	*	0.103	
KIS, change in employment share							0.0232		-0.0026		0.00588	
Internet accessibility	-0.79		-0.173		5.003		1.25		-0.782		16.7	
Institutional quality	-0.0066		0.00504	***	0.0953		0.00842		0.00663	**	0.0461	
Physical infrastructure	0.000643		-0.00133		-0.145		0.00035		-0.00349		-0.0795	
Innovation potential	-0.00303		0.00145		-0.0284		0.00233		0.00607	*	-0.052	
Highly educated, share	0.00461		0.00271		0.265		-0.00435		-0.00353		0.295	

	SOUTH 2009-2019		NORTH 2009-2019		EAST 2009-2019		SOUTH 2009-2019		NORTH 2009-2019		EAST 2009-2019	
Urban dummy	0.00507		-0.00531		1.397		-0.021		-0.0253		0.601	
Rural dummy	-0.00823		-0.0295		-1.833		0.0363		0.0111		-1.13	
Total effects												
Initial GDP	-0.935	***	-0.333	***	-2.101		-1.256	***	-0.606	***	-3.85	*
Investment rate change	0.0296	**	0.0484	***	-0.162		0.0167		0.0782	***	-0.171	*
Average investment rate	0.042		0.0143		0.526	*	-0.0146		0.0313		0.294	
Agriculture, change in GVA share	-0.0417		-0.267	***	-0.439	*						
Industry, change in GVA share	0.00626		0.207	***	-0.034							
Advanced services, change in GVA share	-0.126	***	0.0597	***	-0.819	*						
Agriculture, change in employment share							-0.0989		-0.0603		0.046	
High-tech manuf., change in employ. share							0.294		0.268	**	1.012	**
Low-tech manuf., change in employ. share							-0.4	**	0.292	***	0.14	
KIS, change in employment share							0.137		-0.00751		0.00798	
Internet accessibility	5.516	***	-0.694		6.469		7.389	***	-2.257		22.67	*
Institutional quality	0.0461	***	0.0203	***	0.123	*	0.0497	***	0.0191	***	0.0626	
Physical infrastructure	-0.00449		-0.00536	*	-0.188	*	0.00207		-0.0101	**	-0.108	
Innovation potential	0.0212	***	0.00585	*	-0.0367		0.0138		0.0175	***	-0.0706	
Highly educated, share	-0.0322	***	0.0109		0.342	*	-0.0257		-0.0102		0.4	*
Urban dummy	-0.0354		-0.0214		1.806		-0.124		-0.0731		0.815	
Rural dummy	0.0575		-0.119		-2.371	*	0.214		0.0319		-1.534	

Note: *** indicate a 0,001 level of significance, ** a 0,05 level of significance.

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